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VOL. XII.

PART II.—JULY TO DECEMBER, 1843.

NEW SERIES.

"It will flourish, if naturalists, chemists, antiquaries, philologers, and men of science, in different parts of *Asia* will commit their observations to writing, and send them to the Asiatic Society, in Calcutta; it will languish, if such communications shall be long intermitted; and will die away if they shall entirely cease."—Sir Wm. Jones.

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JOURNAL

OF THE

ASIATIC SOCIETY.

Memoir on Indian Earthquakes. By Lieut. R. Baird Smith, *Bengal Engineers.*

Part II.—*Historical Summary of Indian Earthquakes, with some Remarks on the general distribution of Subterranean Disturbing Forces throughout India and its Frontier Countries.*

The following summary is offered, not as a perfect Register of the Earthquakes that have occurred in India and its adjoining countries during past times, but rather as a first step towards the formation of such a Register, which from its nature, must necessarily be a work requiring much time and much research. The requisite materials are scattered in detached notices throughout numerous works, to a limited number only of which, circumstances admit of my having access. I cannot therefore but feel conscious of the imperfections of this first effort to trace the history of Indian Earthquakes, and I would solicit the assistance of those who feel an interest in the subject, in so far as to furnish me with accounts of Earthquakes I may have omitted to notice, or with references to the sources whence such accounts are to be obtained. Materials thus furnished by the combined efforts of many would accumulate, and in process of time it might be hoped, that from them a complete historical summary of our Earthquakes may be prepared.

While as a matter of curiosity, it would be interesting to trace the occurrence of Earthquake shocks in this country, to the earliest practicable periods, I feel very doubtful whether the results obtained, would be of scientific importance sufficient to afford any adequate compensation for the time and labour that must be expended upon the work. Native authorities must be almost exclusively depended upon, and accounts of events of this class furnished by such authorities are invariably, in so far as I am yet acquainted with them, of a very unsatisfactory character: confined usually to a mere record of their occurrence, or if extending beyond this, to a detail, in exaggerated terms, of the destruction in life and property caused by them. It is not until European intelligence has been brought to bear upon the phenomena of Earthquakes in India, that the records become of scientific value, and it is to these records, (unfortunately much more limited than is desirable,) that any interest the following summary may be found to possess, is chiefly attributable. Imperfect, however, as notices of shocks by native authors certainly are, I am very anxious to procure as many of

them as possible, and any furnished me will be thankfully acknowledged.

Two methods of arrangement for the materials of this summary present themselves; first, the Earthquakes may be recorded in simple chronological order, without reference to any other circumstance than their succession in time: or second, neglecting their chronological order, they may be formed into groups according to the localities whence they have emanated. The latter appears to me, for several reasons, the preferable of the two: it is more methodical, it affords a species of natural arrangement for the shocks, and it indicates the general distribution of the forces to which the shocks are due. The Earthquakes herein described have therefore been arranged according to the localities from which they have proceeded, as indicated by the best information obtained.

1. *Earthquakes of the Central Himalayan Tract.**

* The information relative to the occurrence of Earthquakes North of the Himalayas which I have been able to collect is so limited, that I have not thought it worthy of being included in the body of this Memoir. I am desirous, however, of placing it upon record, and I do so in the form of a note.

On the night of the 22nd January 1832, a destructive Earthquake occurred in the valley of the Oxus, extending thence across the Hindoo Khoosh to Moultan and Lahore. The late Sir A. Burnes thus alludes to its effect, in Buduckshan (Travels in Bokhara, &c. vol. III. p. 176,) "This country also suffered from an Earthquake in January 1832, which destroyed many villages, and a great part of the population. The roads in many parts of the country were blocked up by the falling of stones, and the river of Budukhshan was hemmed in for five days by a hill that tumbled in upon it. This great convulsion of nature occurred at midnight, and scarcely a family in the country hut deplored the loss of some of its members. It was felt at Moultan and Lahore, but the centre of its violence appears to have been the valley of the Oxus."

The following extract of a letter from the same officer, dated Lahore, 23rd January 1832, published in the Journal of the Asiatic Society, vol. I. p. 34, gives an account of the shock as felt at that city, with some other interesting details connected with the Earthquakes of those parts of India generally:—

"As you will have perceived by the date of my letter, I have crossed the frontier, and am now at Lahore. An event occurred here last night, which I am sure will prove of interest to you—a severe shock of an Earthquake. There were two distinct vibrations, the last continuing for about ten seconds with alarming violence. It occurred eventually at 11 P. M. after we had retired to bed and were asleep. The door of my apartment and all the furniture were shaking with a rattling noise, when I awoke and ran into the open air. The house in which we are lodged is a most substantial dwelling of two stories, built of brick and chunam, being the garden house of M. Allard, and yet it was shaken most violently.

"I am informed by the Chevalier, that Earthquakes are of frequent occurrence in this city, especially in winter, but he does not remember so violent a vibration as that I have just mentioned. The shock was from East to West, or rather from South-east to North-west. The lofty minarets of this city afford however convincing proof, that there can have been no very violent commotion of nature within these 200 years. The Earthquakes of Cashmere are frequent, and the natives inform me, that the shocks are more severe nearer the mountains.

"I should mention that the atmosphere had indicated nothing unusual before the Earthquake, nor did the Barometer undergo any variation before or after it. The Thermometer stood at 37°; for the last ten days it has been 4° below the freezing point every morning at sun-rise, a much greater depression than I had expected in the Punjaub, where it rose to 102° daily when I was here last July."

This Earthquake appears to have been felt throughout Yarkand, Kokan, and other parts of Chinese Tartary, as it is stated by W. H. Wathen, Esq. in a Memoir on Kokan, published in 1834, and founded on information furnished by Usbek pilgrims, that a few years previous, dreadful Earthquakes had devastated the whole of that territory. The following extract from a Memoir on Chinese Tartary, by the same gentleman,

Earthquakes of 1803.—This is the first Earthquake emanating from the central portion of the Himalaya range, of which any authentic information has been obtained. Its destructive effects were chiefly experienced in the mountain provinces of Sirmoor, Gurwhal and Kumaon, although its influence is said to have extended throughout the whole of the plains of Hindostan, from the Himalayas to Bengal.

The following details connected with it, are given in the "Gleanings of Science," vol. II, p. 50, by a writer, who though signing only his initials, may readily be identified with Colonel Hodgson, late Surveyor General of India, from whose accounts of his journeys in the Himalayas nearly all my information relative to this Earthquake has been obtained.

"I will in a general way notice among many other peculiarities of the mountains, some of the most remarkable. And first, of the Earthquakes which are more frequent in their occurrence, and more destructive in their effects than in the plains. You may have heard of the Earthquake of 1803, which was considered violent in this country, and many buildings were damaged over the whole extent from Bengal to the Punjaub: but in the mountains its effects were terrible, and a great part of the population perished; whole villages having been buried by the fall of cliffs, and sliding down of the faces of the hills. The scenes of that havoc have often been pointed out to me; the imagination can hardly form an idea of a more terrible event than such a catastrophe. What can be the reason of those more violent shocks in the mountains than in the plains? We saw no volcanoes, nor heard of any, and I believe there are none; thunder and lightning

(Journal Asiatic Society, vol. IV, p. 659,) indicates the volcanic nature of the localities under notice:—

"*Volcanoes—Sal-Ammoniac.*—At a distance of ten days journey from Auksú, (which lies North-east from Yarkand, about 20 days Caravan travelling,) are two very high ranges of mountains, between which there is a valley, the surface of which to a considerable depth, is covered with Sal-Ammoniac. There is a dreadful heat at this place, occasioned by a volcano which, by the people of the country, is called "God's Fire." The heat prevents them from approaching it in the summer; during the eruption the Sal-Ammoniac is said to be thrown out, and showered over the valley like mist, to the distance of one kos: it afterwards hardens, and becomes during the winter crystallised like ice. People go there at that season, cut it into convenient pieces, and carry it away. It is said that near old or Koneh Turfan also, is a mountain out of which flames of fire are seen to issue.

"*Earthquakes—Cholera.*—The natives state, that about three years ago (1832-33) there were constant Earthquakes in the province, and that Cholera committed great ravages at Yarkand. In Badakhshan, the Earthquakes destroyed a great number of houses and people."

Similar indications of volcanic action are continued throughout the territory of Iskardoh, where hot springs are numerous, the temperature of some of which is so high, that when a drop of the water is placed on the skin, it immediately raises a blister. (J. A. S. vol. IV, p. 594.)

Throughout the whole of Thibet copious hot springs occur, some of very high temperature, but I have not obtained any information relative to the occurrence of Earthquakes in that country. M. Alexander Csoma de Körös, in his Geographical notice of Thibet, (J. A. S. vol. I, p. 126,) mentions that between U and Ts'ang in Thibet Proper, there are hot springs used in curing cutaneous diseases and the gout. But such hot springs are numerous in the mountains lying East from the Ma-p'han Lake: especially at one place there is a hole out of which continually issues vapour, and at certain intervals, hot water is ejected with great noise, to the height of twelve feet.

are much less frequent in the upper mountains than in the plains, and I do not recollect any, except once on the way to Jumaotree, at a place near the bed of the river, and not more than 8,000 feet above the level of the sea."

Colonel Hodgson, in his Survey of the Rivers Ganges and Jumna, (Asiatic Researches, vol. XIV, p. 139,) under date the 13th of April, 1817, from Thano to Catnaur, farther remarks:—

"After passing the worst part (of the route between the two above-mentioned places,) descended to Oj'ha Ghur, a hamlet of three huts only, at the foot of steep and lofty cliffs, the rocks hurled from which by the Earthquake of 1803, buried a small fort and village, which once stood here; dreadful mementous are seen in the mountains of that catastrophe. Under Oj'ha Ghur, a stream falls into the Jumna, and several cataracts are seen falling among the surrounding precipices. There are some hot springs at the bed of the Jumna, which is 400 feet below the hamlet. Latitude observed 30° 54′ 47″."

The city of Sreenuggur, the capital of the mountain province of Gurhwal, suffered severely from the same shock. James Fraser, Esq. in his Tour in the Himalayas (p. 369,) thus alludes to the circumstance:—

"Sreenuggur, the chief town or capital of Gurhwal, is situated on the South bank of the Alacnanda, about twenty miles above its junction with the Bhagiruttee at Deopragur, where a strip of level ground stretches along for three or four miles, forming the valley known by the same name as the town. It was once comparatively populous and prosperous, forming as it did, not only the residence of the court, but a considerable entrepôt for the produce of the various countries in and on either side of the snowy mountains, which exchange commodities by the Nitteemānā and other Passes.

"When Colonel Hardwicke visited this place in 1796, it was perhaps not in its prime, but contained (as he computed) 700 or 800 houses and a good bazar. When Messrs. Webb and Raper, in 1808, passed through it on their way to Buddreenauth, it had sunk deeply in importance, and was to all appearance rapidly advancing to decay. It had not only to contend with the common enemies of the country, but also with natural causes no less ruinous. An Earthquake had occurred in 1803, which had done considerable injury: many houses were ruined, and the Rajah's palace was particularly shattered; and the encroachments of the river Alacnanda yearly destroy a portion of that which yet stands, threatening in time to sap the foundations of all."

Buddreenauth, the celebrated resort of Hindoo pilgrims, situated near the sources of the Alacnanda River, one of the tributaries of the Ganges, did not escape the destructive effects of the Earthquake of 1803. After describing the principal temple at this holy spot, Captains Webb and Raper continue thus:—

"The era of its foundation is too remote to have reached us, even by tradition; but it is considered the work of some superior being. This specimen of divine architecture, however, was too weak to resist the shock of the Earthquake, which left it in so tottering a condition,

that human efforts were judged expedient to preserve it from ruin : and the repairs which it has lately undergone, have completely modernised its external appearance. The body of it is constructed of large flat stones, over which is a coat of fine white plaster, which adds to the neatness, but has destroyed all outward pretensions to antiquity."

Several hot springs in the vicinity of this temple are then described. One is received in a large cistern, which is called the Tapta-cund, and forms a warm bath for the pilgrims, supplied by a hot spring issuing from the mountain through a subterraneous passage. The water of the Tapta-cund is as hot as a person can bear, and from it issues a thick smoke or steam, strongly tainted with a sulphureous smell. A little to the left of it, is Surya-cund, another hot spring, and besides these, are many more, all of which are turned to due account by the Brahmins of the Temple.

The large town of Barahal on the Bhagiruttee river, also a favourite resort for pilgrims, is the only other place in this neighbourhood which is specifically mentioned as having been injured by the Earthquake under notice. All its temples were more or less shattered, and many of its houses ruined, so that when visited by Mr. Fraser in 1815, it presented a miserable spectacle of dilapidation and filth. Before this catastrophe, it is said to have had fifty or sixty shops with a well frequented bazaar and numerous shrines and temples; after it, a few mud huts with the ruin of former buildings alone remained. Whether since the period of Mr. Fraser's visit it has recovered any portion of its former prosperity I am not aware, but it is still largely frequented by pilgrims, and abounds in Bramins and Fakeers.

I have not been able to obtain any specific information relative to the ravages of the Earthquake in Kumaon, beyond the fact, that they were not less severe there than in Gurhwal, involving the destruction of life and property to a great extent.

The information obtained is not sufficiently precise to warrant any attempt being made to define the extreme limits of the shock of 1803, nor to trace it to any special spot as its focus of emanation. According to Captain Hodgson's statement, it injured buildings throughout the whole plains of Hindoostan, and if so, it must have been one of the severest shocks ever experienced in this country. Its fearfully increased intensity in the mountains, shews very distinctly that it was in them it had its source, and I have therefore had no hesitation in assigning it to the Central Himalayan tract. It can only however be thus referred in general terms, since to do more would require details much more minute and specific than, from the nature of the case, it is practicable to collect. This remark, I may here state, applies generally to the arrangements employed throughout this summary. The precise spots from which Earthquake waves diverge, have been fixed in some cases, particularly in Scotland, but to do this has required the employment of careful and constant observation, aided by registering instruments. The same effort cannot be made in India until the same materials have been collected, and all I have attempted is therefore

only to assign Earthquakes generally to those tracts from which, according to the best information procured, they seem to have proceeded.

Earthquake of 1809.—The only reference to this Earthquake which I have been able to find, is contained in the following Extract from a paper by H. Falconer, Esq. on the great Cataclysm of the Indus in 1841, (J. A. S. vol. X, p. 618). Having suggested the possibility of the bed of the river having been blocked up at a point high in its course, by mouutain masses precipitated by an Earthquake, he adds, "An event of this sort is not improbable, for we know that in 1809, an Earthquake of such force took place in Gurhwal, that the Bishnoo-Gunga river, one of the great branches of the Ganges, was blocked up below Goseenauth by a landslip, and the water rose to 40 feet above its usual level." I had hoped to have been furnished by Dr. Falconer with a reference to the source whence this information was derived, but circumstances unfortunately arose which prevented his turning his attention to the subject, and I was accordingly disappointed in my hopes.

Earthquake of the 26th May, 1817.—This Earthquake was experienced at Gungoutri, the source of the river Ganges, by Captains Hodgson and Herbert, during their Survey of the Himalayas. The former in his Journal, (Asiatic Researches, vol. XIV, p. 98,) thus graphically describes the effects of the shock: "At night having prepared the instruments to take the immersion of one of Jupiter's satellites, we laid down to rest, but between 10 and 11 o'clock were awakened by the rocking of the ground, and on running out, soon saw the effects of an Earthquake, and the dreadful situation in which we were pitched in the midst of masses of rock, some of them more than 100 feet in diameter, and which had fallen from the cliffs above us, probably brought down by some former Earthquake.

"The scene around us, shewn in all its dangers by the bright moon light, was indeed very awful. On the second shock, rocks were hurled in every direction from the peaks around to the bed of the river, with a hideous noise not to be described, and never to be forgotten: after the crash caused by the falls near us had ceased, we could still hear the terrible sounds of heavy falls in the more distant recesses of the mountains. We looked up with dismay at the cliffs overhead, expecting that the next shock would detach some ruins from them: had they fallen we could not have escaped, as the fragments from the summit would have flown over our heads, and we should have been buried by those from the middle.

"Providentially there were no more shocks that night. This Earthquake was smartly felt in all parts of the mountains, as well as in the plains of the North West Provinces of Hindoostan." On measuring the height of the cliff under which he was when the shock was felt, Captain Hodgson found it to be 2,745 feet.

In his Journal under date the 30th May, Captain Hodgson remarks: "6. Road most difficult, over masses of rock which have fallen from above into the stream. This station is full of peril, being a very

recent slip of the whole face of the mountain to the left. The broken summits cannot be less than 4,000 feet high: blocks threaten to fall, and are now indeed continually coming down: I have not seen so dangerous a slip. The ruin extends about half a mile: every person made the greatest haste to get past this horrid place. The fracture of the rocks is so fresh, that I suspect this havoc must have been caused by the Earthquake of the 26th, for we heard a great crash in this direction."

The whole of the gigantic accumulations of snow and ice at the *debouche* of the Ganges were found by Captain Hodgson shattered and riven in every direction, and so fresh were the fractures, that he attributed them almost entirely to the Earthquake. These beds were not less than 300 feet in thickness, formed of solid frozen snow, and extending for 4 or 5 miles, as far indeed as the bounding mountains permitted.

In the letter previously quoted, Capt. Hodgson states, "The Earthquake at Gungoutri was by far the most alarming phenomenon of nature I ever witnessed, and the frequent, almost daily, recurrence of the shocks, though slight, made us uneasy, as it shewed that there was some active agent at work perhaps under our feet, which might at any instant bring down the cliffs beneath which we scrambled along on our hands."

The range of this shock appears to have been the same as that of 1803, and its intensity could scarcely have been much inferior. No accounts, however, of any destructive effects on the towns in the Himalayas, have come under my notice, although from the vicinity of some of them to Gungoutri, they could hardly have escaped the effects both of the vibrations and the land-slips caused by them. The dislodgement of a mass of rock 4,000 feet in height and half a mile in length, gives an appalling idea of the intensity of the disturbing force, while it proves how very probable it is, that many of those sudden depressions and elevations of rivers having their sources in mountains liable to such convulsions, are caused by land-slips of this nature. Captain Hodgson alludes to numerous other enormous slips observed after the Earthquake, and to many he assigns the same origin as to that above-mentioned, while others appeared older, and due either to previous convulsions or to the disintegrating effects of atmospheric agents.

Earthquakes of the 27th and 28th May, 1817.—These two shocks are recorded in the same Journal from which the preceding details have been taken. They were both slight in comparison with that of 26th, but still sufficiently severe to cause considerable anxiety to the travellers, and to make them anxious to remove as soon as possible from the spot.

During the same month in which the preceding three shocks occurred, it is stated by Captain Hodgson, that no less than forty others were felt in the districts of Kamaon, of variable intensity, but none very severe, with the exception of that of the 26th.

From the year 1817 to 1831, a blank in the record of central Himalayan Earthquakes occurs, and if during that time any have been

noticed, I have not been fortunate enough to discover them. From 1831 to 1835, a register of the shocks felt at Lohooghat in Kamaon is given in Dr. McClelland's Geological and Statistical Account of that district. Judging from the direction of the larger portion of these shocks, there can be little doubt of their having emanated from the centre of the Himalayan chain, and to this source they are attributed by Dr. McClelland. A few are doubtful, but in default of better evidence, I have included these among the Earthquakes of the central Himalayan region.

Earthquake of the 25th December, 1831.—This shock occurred at 9 P. M. Its duration was about seven seconds, and its direction on a North-west and South-east line. The motion of the earth was undulatory, and the intensity appears to have been slight.

Earthquake of the 2nd July, 1832.—The period of this shock was 11 P. M. "During twelve seconds," Dr. McClelland states, "the earth shook, or rather trembled, and afforded a noise which it is difficult to describe, but which may be compared to the sound of a heavy but transient rush of water. The noise preceded and succeeded the motion about three seconds."

Earthquake of the 18th August, 1832.—Time of shock 7 A. M. The earth trembled for about the space of five seconds: no peculiar concomitant circumstances were observed, except that the weather at the time was hot and sultry.

Earthquake of the 23rd September, 1832.—Time of shock 10 P. M. The circumstances of this shock were in all respects similar to those of the Earthquake of the 2nd July 1832.

Earthquake of the 30th May, 1833.—The earth was found to shake rather violently for about twelve seconds at 12 P. M. It was attended with a noise like that already described.

Earthquake of 4th January, 1835.—About 7 A. M. a slight shock was felt which lasted from fifteen to twenty seconds, but the motion of the Earth was very gentle, and seemed to be on a line between North and South, accompanied by a noise as usual.

Earthquake of the 14th January, 1835.—About $1\frac{1}{2}$ A. M. a shock which seemed to be in the direction of North-west, and more violent than the one on the 4th took place, accompanied by a noise like distant thunder. The motion was tremulous: and in crossing the strata, it seemed to affect one at a time.

At this point Dr. McClelland's register terminates, and no further shocks, to the best of my knowledge, are recorded until the year 1842, when a few of those noted in my register for that year, may be assigned to the tract now under examination. As all the circumstances accompanying these shocks are stated in detail in the register, it will be necessary for me to do little more here than simply to state their dates.

Earthquake of the 5th March, 1842.—Although no information relative to this Earthquake has been obtained from any point farther in the interior of the Himalayas than Simlah, it appears probable from its direction, that it emanated from the central tract, and to this I have

referred it. The intensity of the shock was much greater at Umpoosie than at any place to the Westward, and it may thence be inferred, that, as its direction was from Northward to Southward, it originated in the upper portion of Gurhwal, a locality from which so many of the Earthquakes just recorded have emanated.

Earthquake of the 7th September, 1842.—This Earthquake was very slight and unimportant, except from the circumstance of its having been accompanied by an electric shock. There is nothing in the information furnished regarding it to enable us to form any decided opinion as to its place of emanation, and it is only on the ground of a slight probability that I refer it to the Central Himalayan tract.

From the preceding details it appears, that including the Kamaon shocks of May 1817, fifty-five Earthquakes have been experienced in the interior of the Himalayas since 1803, by far the larger portion of which, may without doubt be assigned to the action of disturbing forces, seated under the main axis of this great mountain range. The unrecorded shocks bear in all probability a large proportion to those recorded, and the preceding statement therefore affords but an inadequate representation of the activity of the forces to which the shocks are due. Before leaving this part of the subject, I may very briefly allude to the physical constitution of the central range of the Himalayas. By the uniform testimony of observers who have penetrated to the Snowy Range, it appears that the mountain masses there are composed of primary Rocks, that granite, gneiss and mica slate are chiefly developed, that trap dykes, having a direction parallel to that of the main chain itself have been found, and that signs of very powerful disruptive action are continually apparent. These facts are all characters of the localities from which Earthquake shocks have been found to emanate in other parts of the world, and are consistent with what, *a priori*, we would be led to anticipate, whether we suppose Earthquakes to originate in the movements of a central fluid nucleus, or in the action of more limited and local forces of chemical or mechanical origin, it is natural to infer that their effects will be more perceptible in localities where the solid crust of the earth is fissured and disturbed, and where many "lines of least resistance", so to speak, are furnished, than in others where the strata are more continuous and unbroken. Hence it has been found that in South America, in Italy, and in Scotland, Earthquake tracts are characterised by marks of violent disruptive action, and indications of the existence of subterranean volcanic forces invariably to be discovered. There is yet another point of analogy between the Earthquake Tract of the central Himalayas, and such tracts in other countries, in the extraordinary prevalence throughout the former of hot springs of very high temperature. Some of thes I will now mention; commencing with the most celebrated, those of Jumnoutri at the source of the River Jumna, 10,849 feet above the level of the Sea. Captain Hodgson, thus describes these springs under date 21st April 1817, (Asiatic Researches. vol. XIV. p. 147.)

"At Jumnoutri the snow which covers and conceals the stream is about 60 yards wide, and is bounded to the right and left by several precipices of granite: it is 40 feet $5\frac{1}{2}$ inches thick, and has fallen from the heights above. The snow is very solid and hard frozen, but we found means to descend through it to the Jumna by an exceedingly steep and narrow dark hole made by the steam (of the springs,) and witnessed a very extraordinary scene, for which I was indebted to the earliness of the season, and unusual quantity of snow which has fallen this year. When I got footing at the stream, (here only a large pace wide,) it was some time before I could discern anything, on account of the darkness of the place, made more so by the thick steam: but having some white lights with me I fired them, and by their glare was able to see and admire the curious domes of snow overhead: these are caused by the hot steam melting the snow over it. Some of these excavations are very spacious, resembling vaulted roofs of marble; and the snow as it melts falls in showers, like heavy rain, to the stream, which appears to owe its origin to these supplies. Having only a short scaled thermometer with me, I could not ascertain the precise heat of the spring, but it was too hot to bear the finger in for more than two seconds, and must be near the boiling point." In a subsequent paper, Captain Hodgson states the temperature of one spring to have been 194.°7 which, for the height of Jumnoutri, is very nearly the boiling point of water. "The range of springs," he continues, "is very extensive, but I could not visit them all, as the rest are in dark recesses and snow caverns. The water of them rises with great ebullition through crevices of the granite rock, and deposits a ferruginous sediment, of which I collected some: it is tasteless, and I did not perceive any peculiar smell. Hot springs are frequent in the Himalaya, perhaps they may be a provision of nature, to ensure a supply of water to the heads of the River in the winter season, when the sun can have little or no power in melting the snows in those deep defiles." Constant references are made in Captain Hodgson's Journal to the frequent recurrence of hot springs of considerable extent and high temperature as spots in the upper portion of the course of the Jumna, and they seem indeed to be distributed in remarkable profusion.

In like manner, while exploring the course of the Ganges, Captain Hodgson found hot springs of high temperature, although apparently not so abundantly distributed as on the Jumna. Again to the Eastward at Kedarnath and Buddreenath, numerous springs occur, while in Kumaon they are equally abundant. At the two first mentioned spots travellers have noticed various subterranean noises, as if gaseous matter was escaping with violence. We are not acquainted with the physical geography of the central Range of the Himalayas in prolongation to the Eastward, but it is probable that the phenomena would there be observed. To the westward again Mr. Moorcroft, Lieuts. Broome and Cunningham have found many hot springs in the upper portions of the courses of the Rivers of the Punjaub, so that their occurrence throughout a large portion of the Himalayan chain is established by direct ob-

servation, while it may with considerable confidence be inferred, that in the unexplored intermediate portions, they would also be discovered.*

A disposition exists to attribute these springs to mere local chemical action, but their universal distribution over so wide a range, taken in connection with the fact, that from this range Earthquakes, sometimes of great violence, are repeatedly emanating, has led me to believe that the two classes of phenomena are intimately connected: in other words, that they are joint effects of the same cause. The hot springs I believe, owe their high temperature to internal chemical action extensively distributed, and the Earthquakes are due to the convulsive efforts of the elastic matter generated by this action, in escaping from the interior of the earth. To attempt to define the nature of this action, while we are wholly ignorant of the chemical composition of the springs would be vain; but I cannot resist the conviction, that the presence of these hot springs and the occurrence of Earthquake shocks are due to one and the same origin. It was, at one time, supposed, that an active volcanic vent had been discovered in the central Himalayan range, but this is now known to have been erroneous, and the only proofs of volcanic action, consist in the occurrence of Earthquakes, the abundant distribution of springs of high temperature, the presence of Trap Dykes, and indications of powerful disruptive action in the strata.

2. *Earthquakes of the Lateral Himalayan Tract.*

Under this Tract are included the Earthquakes that have been felt throughout the valleys along the Southern Face of the Himalayan range, situated at heights varying from 6,000 to 2,000 feet above the level of the sea. It is proposed to commence with the most Westerly of these, relative to which any authentic information has as yet been obtained, namely that of Cabool; and having narrated the history of the Earthquakes of that valley, to proceed in a regular manner to the Eastward. Earthquakes of considerable severity have, I believe, been

* The following extract from a letter from A. Campbell, Esq., Political Superintendent of Darjeeling, furnishes some notices of hot and mineral springs in the extreme Eastern portion of the Himalayas.

"*3rd Hot and mineral springs.*—On the west bank of the Mechi River within the hills, at about six miles above Mechi Gola, there is a mineral spring which runs into the Mechi. I have visited it. The water is quite clear as it issues from the rock, but on the small flat space below there is a reddish deposit, carbonate of iron, I believe. This water has medical virtues ascribed to it. It is heated and used as a bath for rheumatism, cutaneous diseases, &c. Iron ore abounds in the neighbourhood of this spring. It is called "Menchoo" by the Lepchas, which means "medicated water."

"There is a hot spring on the east bank of the great Runjeet River, one day's journey from the monastery of Pemlong. It is called "Puklong Sachoo" (Sachoo means hot spring.) The water has a disagreeable smell, and deposits a whitish substance which is used in medicine.

"There is another hot spring called "Phoog Sachoo," also on the east bank of the great Runjeet, one day's journey to the East of Rinchungpoong. Its deposit is also whitish and its water fetid. I have not visited the two latter nor do I know how far they are apart. They are both in Sikkim, and about three days journey from Darjeeling."

Dated October 7th, 1842.

occasionally experienced to the Westward of Cabool, and especially felt at Herat, but I regret to say I have not succeeded in procuring any information connected with them, beyond the mere fact of their occurrence. Details of Earthquakes at Herat are given, I understand, in the Zil-Zillee-Nahmah, a native work on the subject, and as I hope shortly to receive a copy of this book, most kindly procured for me from Cashmere by George Clerk, Esq. Envoy to the court of Lahore, I may be able at a future time to give some account of them.

A. Earthquakes of the Valley of Cabool.

The earliest notice of an Earthquake in the valley of Cabool which I have found, is of that which occurred in the year 1505, during the reign of the Emperor Baber. Lieut. Burnes, (the late Sir Alexander Burnes,) thus alludes to this event in a paper on the Reg-Rewan, a singular phenomenon of sound near Cabool, published in vol. VII, Jour. As. Soc. p. 325, "Convulsions of nature are, however, exceedingly common in this part of the world. Baber mentions one to have occurred in his time, and in this very plain, so that "in some places the ground was elevated to the height of an elephant above its old level, and in others as much depressed." The same event is thus adverted to in Daw's translation of Ferishta's History of Hindoostan. "In the year 911 H. (A. D. 1505,) Cabulistan was thrown into great consternation by dreadful Earthquakes, which laid most of the cities in ruins. Baber endeavoured to alleviate this public calamity in such a manner that by his unwearied care, and extensive benevolence, he gained the love and fidelity of all his new subjects."

The Earthquake of 1505, must have been one of great violence, judging from the alterations of the levels of the ground mentioned by Baber, and the extensive destruction of the cities alluded to by Ferishta. Perhaps in both some allowance must be made for oriental exaggeration, but Baber was so remarkable for his minute observations on all natural phenomena which interested him, that less allowance is called for in his case, than in others. From its effects the shock appears to have been felt over nearly the whole of Affghanistan, and the parts which suffered so severely were probably Cabool, Candahar, Ghuzni, and Jellalabad, with others of less note.

A long interval of upwards of three centuries, now occurs during which time I have found no reference to Earthquake shocks in the Cabool valley. That they continued frequently to be felt, I have no doubt, as the inhabitants had become so far familiarised with their phenomena, as to have terms in their language for the varieties of shocks. "A passing shake with a rumbling noise," remarks Sir A. Burnes, in the paper previously quoted, "is called 'Goozur,' to distinguish it from Zil-Zillee, or Earthquake, which the inhabitants denominate a motion that is tremulous." And from time immemorial it has been found necessary to construct the larger number of the houses at Cabool, of wood, to enable them to resist better, the constantly recurring shocks. In the year 1808, Mr. Elphinstone (Journey to the Court of Cabool, vol. ii, p. 173,) "Most of the buildings of Cabool are

of wood, a material recommended by its power of resisting the frequent Earthquakes with which this place is visited. It is not improbable that the Zil-Zillee-Namah, may furnish some materials for filling up this long interval, but from this little more I fear can be expected than a mere narrative of the effects of shocks, since more intelligence than its author could have possessed is necessary to distinguish the phenomena, which point to the causes of these convulsions.

It is not until the year 1829, that we have any specific notice of another Earthquake in the Cabool valley. This notice is a very brief one by Sir A. Burnes. About six years previous to his visit to Cabool in 1836-37, a very severe Earthquake had been felt at that place, and he adds, that shocks happen so frequently as twice and thrice a month. On one night, the 14th December 1837, he mentions that no less than three shocks were experienced.

In 1836, Mr. Vigne mentions* several shocks of Earthquakes were experienced by him at Cabool, all however slight, and he adds that the average number of shocks during the year is about twelve. Mr. Masson also† records the occurrence of several during his residence at the capital of Affghanistan. The notices of both of those travellers are however very meagre, and the shocks seem to have been so frequent, as to deprive them of interest in their eyes.

The preceding form all the information I have been able to collect relative to the Earthquakes of the Cabool valley. The details are, it will be observed, of a very limited character, and establish only the general fact, of disturbing forces being continually in operation beneath this valley, with the additional circumstance of considerable alteration of levels having been the effect of one of the shocks, that namely of 1505. It is impossible to say whether or not all the shocks are local, and due to forces acting immediately under the valley of Cabool. The whole of the tract around is said to exhibit indications of volcanic action, and it is probable therefore, that many of the numerous shocks may be secondary ones, having originated either to the Eastward or Westward. I am indebted to Captain Hutton, Bengal Army, for the following remarks on this point, which shew the general prevalence of volcanic action throughout the country around Cabool, although nothing is said relative to such action within the valley itself. Captain Hutton thus writes: "It was reported by some intelligent men whom I met with at Candahar, that a volcano exists in the Huzzareh mountains (to the westward of Cabool,) but that few are living (1840) who remember to have seen it active. The appearances of a volcanic mountain, the effects, &c. were so well described, that I can hardly think they were deceiving me. All Affghanistan gives indication of violent volcanic action, and the country from the Kojuck range to beyond the Helmund, may be termed a volcanic district, the mountains being usually accompanied along the base by a low range of basaltic or other trap rocks."

* Vigne's Travels, p. 812. † Masson's Travels, vol. III. p. 8.

B. Earthquakes of the Valley of Jellalabad.

In the Register of Earthquakes for 1842, I have stated the grounds on which I consider the valley of Jellalabad to be the seat of Earthquaking forces. It is well known that the areas over which the causes of such forces (of whatever nature we may consider these) extend, is frequently very great; and that a connection may exist between the forces that disturb the Cabool and Jellalabad valleys, is more than probable. But, from the information as yet obtained, it is justly to be inferred that these forces act independently, and I have therefore placed the two valleys as distinct portions of the lateral Himalayan tract.

Our information relative to the Earthquakes of the Jellalabad valley is all subsequent to the year 1842. Since the publication of the Register for that year, I have obtained some farther information relative to the Earthquakes of this locality, which I purpose giving here.

Earthquake of 19th February, 1842.—The following extract from Lady Sale's Journal of the imprisonment, gives details of the shock as experienced at the fort of Buddeabad, in the valley of Lughman:—

"At noon I was on the top of the house, when an awful Earthquake took place * * * *. For some time I balanced myself as well as I could, till I felt the roof was giving way. I fortunately succeeded in removing from my position before the roof of our room fell in with a dreadful crash * * * * * *. When the earthquake first commenced in the hills in the upper part of the valley, its progress was clearly defined coming down the valley, and throwing up dust like the action of exploding a mine. Our walls and gateways and corner towers, are all much shaken, or actually thrown down. We had at least twenty-five shocks before dark, and about fifteen more during the night, which we spent in the court yard. * * * * Our fort is the best of forty that have suffered in this valley, and many are entirely thrown down. In one a tower fell and crushed five women and a man, others have not a wall remaining."

Lieut. Vincent Eyre thus describes the same event. (Military Operations at Cabool, p. 262.)

"February 19th. On the 6th we had a heavy fall of rain, since which the weather had become exceedingly close. This morning it was observed that an unusual degreee of heat and stillness pervaded the air. Whether these were premonitory symptoms of what was to happen it is impossible to determine: but at 11 A. M. (?) we were suddenly alarmed by a violent rocking of the earth which momentarily increased to such a degree, that we could with difficulty maintain our balance. Large masses of the lofty walls that encompassed us fell in on all sides with a thundering crash. A loud subterraneous rumbling was heard as of a boiling sea of liquid lava, and wave after wave seemed to lift up the ground on which we stood, causing every building to rock to and fro like a floating vessel. After the scenes of horror we had recently witnessed, it seemed as if the hour of retribution had arrived, and that heaven designed to destroy the blood-stained

earth at one fell swoop. The dwelling in which we lodged was terribly shaken, and the room inhabited by Lady Sale fell in, her ladyship, who happened to be standing on the roof, having barely time to escape. Most providentially all the ladies with their children made a timely rush into the open air at the commencement of the Earthquake, and entirely escaped injury. General Elphinstone being bed-ridden, was for several moments in a precarious position, from which he was rescued by the intrepidity of his servant, Moore, a private of H. M. 44th, who rushed into his room, and carried him forth in his arms. * * * * *. The quaking continued for several minutes with unabated violence, and a slight tremor of the earth was perceptible throughout the remainder of the day. The Affghans were for the time-being overwhelmed with terror: for though slight shocks of Earthquake are of common occurrence in every year during the cold season, none so fearful as this had visited the country within the memory of the present generation. We shortly learned that our fort had been singularly favoured; almost every other in the valley having been laid low, and many inhabitants destroyed in the ruins. The town of Turghurree especially seems to have suffered severely, scarcely a house being left standing, and hundreds of people having been killed in the fall.

"Shocks of Earthquakes continued to occur every hour: some of which were rather severe."

Lady Sale records farther shocks on the following days:—

22nd February.—We had Earthquakes day and night; less severe but equally frequent. * * * * * *

23rd February.—This has been a very close and gloomy day: Earthquakes frequent, and some very sharp ones.

24th February.—Very few shocks and those gentle ones; but all last night and great part of to-day, particularly late in the evening, there was a tremulous motion as if a ship had been heavily struck by a sea, generally feeling as if on the larboard quarter, and accompanied by a sound of water breaking against a vessel. At other times we have just the undulatory motion of a snake in the water: but the most uncommon sensation we have experienced has been that of a heavy ball rolling over our heads, as if on the roof of our individual room, accompanied by the sound of distant thunder.

Lieut. Eyre's narrative furnishes me with materials for continuing the list of shocks.

March 3.—Under this date Lieut. Eyre remarks, that severe shocks of Earthquake continued every day.

April 20.—There was a severe shock of an Earthquake again to-day. These shocks have always appeared to me to be in some way connected with heavy rain before-hand.

June 4.—A shock of an Earthquake felt to-day.

June 10.—A smart shock of Earthquake felt during the night.

June 29.—A shock of Earthquake.

Unfortunately no detailed Register of the numerous Earthquakes experienced at Jellalabad during the same time as the preceding has, to

my knowledge, been kept. Shocks continued, however, to be experienced in that valley up to a period later than recorded in any of the Journals of the British prisoners in Affghanistan which I have yet seen. Two are noticed in the Register for 1842: namely, the Earthquake of the 21st July 1842, and that of the 25th of October of the same year, and with the latter, our information relative to the Earthquakes of the valley of Jellalabad terminates.

There are some very interesting points connected with the Earthquakes of this tract to be discussed, but I reserve all comment upon them until I enter upon the third part of this memoir.

C. Earthquakes of the Valley of Cashmere.

From remote antiquity, Earthquakes are known to have been experienced throughout the valley of Cashmere, but so far as I yet know, the dates of these have not been recorded, nor have any of their phenomena been described. The shocks, however, have never been of great violence, although it has been found necessary to provide against their effects by employing wood largely in building.* In describing the Juma Musjid, or

* Since the above was written, I have been favoured with a sight of a copy of Vigne's Travels in Cashmere, by Dr. Jameson, in which some detailed information relative to Earthquakes in the valley is to be found. It is too late now to include this in the body of the memoir, and I am therefore obliged to give it in this form.

"On the night of the 26th June 1828," Mr. Vigne remarks, (vol. i, 281,) "at half past ten, a very severe shock was felt, which shook down a great many houses and killed a great number of people: perhaps 1,000 persons were killed and 1,200 houses shaken down: although being built with a wooden frame-work, the houses are less liable to fall than an edifice of brick or stone. The earth opened in several places about the city: and fœtid water, rather warm, rose rapidly from the clefts and then subsided. These clefts being in the soil, soon closed again, and left scarcely any traces. I saw the remains of one fifteen yards long and two wide: but it was filled up or nearly so. Huge rocks and stones came rattling down from the mountains. On that night only one shock took place: but just before sun-rise there was another, accompanied by a terrific and lengthened explosion, louder than a cannon. On that day there were twenty such shocks, each with a similar explosion.

"The inhabitants were of course in the open country. The river sometimes appeared to stand still, and then to rush forward. For the remaining six days of Zillheja, and the whole of the two next months of Moharrem and Safur, there were never less than 100, and sometimes 200 or more shocks in the day, each accompanied by an explosion: but it was remarked, that when the explosion was loudest, the shock was the less. On the sixth day (after the great shock?) there was one very bad shock, and on the fifteenth, at three o'clock, was the worst, and there were three out of the whole number that were very loud.

"At the end of the two above-mentioned months, the number decreased to ten or fifteen in the 24 hours, the noise became less, and the Earthquakes gradually ceased. About this time the cholera made its appearance. A census of the dead was taken at first, but it was discontinued when it was found that many thousands had died in twenty-one days.

"In Cashmere there had been no great Earthquake before, within the memory of any living person, excepting one about 50 years ago, which was rather severe, and lasted at intervals for a week. An Earthquake is mentioned in Prinsep's Tables, as having taken place in A. D. 1552. Shocks are now common, and the houses are built with a wooden frame-work so as to resist them. They are still more common I should say at Kabool, where I have felt three or four in four months: but they are usually too slight to do harm."

The following is Mr. Vigne's account of the "burning ground" alluded to above.

"The most singular place in Cashmere is Sahoyum, the "burning ground" mentioned by Abul Fuzl, in the Ayin Akberi. It lies near the village of Nichi-Hama, in the pergunnah of Muchipoora, at the north-west end of the valley where the plain is about 6100 feet in height. About thirty-six years ago, an intense heat was found to

great mosque in the city of Cashmere. Mr. Moorcroft, (Vol. II, p. 121,) states, "that the structure consists in great part of wood, and the three hundred and eighty pillars which ornament the temple are composed of square blocks of deodar, built up like brick-work in alternate beaders and stretchers, as the form of bond is technically called." "The peculiarity of their structure," Mr. Moorcroft remarks, "was no doubt suggested by the occurrence of Earthquakes, which are frequent in Cashmere, though not very violent. Certain it is, that although the roof and walls have been rent and shattered in various places, not one of the pillars appears to have been seriously injured, or to have deviated from its original perpendicular." "The traditions of the country assert," says Mr. Moorcroft in describing the valley of Cashmere, (Vol. II. p. 109,) "that the whole of Cashmere, intending thereby the principal line of valley, was originally one large lake, and the aspect of the province confirms the truth of the legend, the subsidence of the waters being distinctly defined by horizontal lines on the face of the mountains: it is also not at all unlikely to have been the scene of some great convulsion of nature, as indications of volcanic action are not unfrequent: hot springs are numerous: at particular seasons the ground in various places is sensibly hotter than the atmosphere, and Earthquakes are of common occurrence." Whether recent travellers who have explored the valley of Cashmere have collected any farther evidence as to the former condition of the province, I am unfortunately unable to say, as I have not yet been able to consult their works. That indications of active volcanic action are numerous and remarkable, I learn from Dr. Falconer, the latest of the Cashmerian travellers. He informs me that a singular "field of fire" exists in the valley, of considerable dimensions, and through crevices in which flames continually issue. The outlines of this volcanic tract are distinctly defined, and the action appears to be strictly local, the soil is completely burnt, and in some spots I believe, petrified. The igneous action has continued now for upwards of two centuries, as the existence of this remarkable spot is certified by Abul Fazil, the learned minister of the Emperor Akber.* Mr. Moorcroft in his travels, (Vol. II.

issue from the spot which is about an acre in size, and in which there are three places more particularly burned. A similar phenomenon had been observed about thirteen years before. The soil, which is a mixture of clay with a little sand, has been fused by the heat from below. One hank is twenty feet above the other. It burned in the time of Atar Mahommed Khan, the Patan Governor, for the space of one month. A white smoke was occasionally seen to issue from the soil, but no fire or sulphureous smell was perceivable, and no fissures opened in the ground. The Pundits hastily assembled from all quarters, scraped away the earth, and placed there their brass cooking pots, with rice and water in them. The rice was cooked in half an hour, and then scattered around for the birds to feed on, the Pundits meanwhile offering up their prayers. No Earthquake took place at the time: no noises were heard, nor did any heat or smoke appear there when the great Earthquake took place in 1828.

"I should think that few would withhold their belief in the fact of volcanic action now being at work under the valley of Cashmere, after listening to an account of this Earthquake." Vol. I. p. 280.

* For the above particulars, I am indebted to Dr. Falconer. They were given verbally, and are quoted from memory, so that they are rather indefinite; but as Dr. Falconer's own account of the phenomenon may be expected ere long, it will be in my power to correct and enlarge the above notice.

p. 277,) mentions a hill within three days' journey of the city of Cashmere, from which loud explosions are heard at intervals, accompanied by the escape of gaseous matter, with force sufficient to tear off the doors and windows of buildings situated upon it. There was nothing on the hill resembling a crater, but the inhabitants on the spot asserted a distinct recollection of the explosions.

About the years 1831-32, a series of Earthquakes occurred in Cashmere, which continued for six months without interruption. These I am informed were chiefly confined to the valley, and scarcely, if at all, experienced beyond it, thus proving the local action of the forces to which they were due. In a letter formerly noted from the late Sir A. Burnes to J. Prinsep, Esq. dated 23rd January (?) 1832, it is stated, "The Earthquakes of Cashmere are frequent, and the natives inform me, that the shocks are more severe nearer the mountains."

That the valley of Cashmere is a focal Earthquake tract, or in other words, that disturbing forces giving rise to Earthquake shocks, are in active operation beneath its surface, and that these forces act independently, and without connection with those of other focal tracts in the Himalayas, are points I think very clearly established by the preceding details. Unfortunately, the nature of the information obtained does not warrant deductions of a more special character, but those actually made, are not devoid of interest, as illustrating the general distribution of active volcanic forces throughout the lateral region of the great mountain range of India.

D. Earthquakes of the Valley of Nepaul.

Traditional accounts of Earthquakes in the valley of Nepaul exist; and in the historical records preserved by the Brahmins of that country, a shock of great severity, by which the cities of Mangah, Patan and innumerable towns were utterly destroyed, and thousands of their inhabitants were killed, is said to have occurred about six centuries ago; but it is not until the year 1833, that we have any detailed accounts of such convulsions. On the 26th of August of that year, a most destructive Earthquake occurred, of which ample details have been furnished by Archibald Campbell, Esq., then Assistant to the Resident at the Court of Nepaul, and accounts of the progress and effects of the shock beyond the valley have been collected and recorded by James Prinsep, Esq. I propose combining the detached narratives of these two gentlemen, so as to form a general account of the course and effects of the shock.

Earthquake of the 26th August, 1833.—The first shock of this Earthquake was experienced at Katmandu, the modern capital of Nepaul, about 6. P. M. It extended throughout the valley and neighbouring hills, being felt Westward in the valley of Nayakot and Dúny Byas: eastward at Panouti, Baneppa, Dulkele and Pholam Chok; and southward at Chitlong, Chisagarby, Etounda and Bissoulea. The shock lasted about 40 seconds, and during its continuance, there was a distinctly audible noise as of ordnance passing rapidly over a drawbridge. This rumbling noise came from the Eastward, and Dr. Camp-

bell says, "I felt it was travelling with the speed of lightning towards the West, and just under my feet: the houses shook most violently, and trees, shrubs, and the smallest plants were set in motion, not shaking, but waving to and fro from their very roots." No injury to life or property was done by this first shock, either in Nepaul or in its course to Calcutta, where it appears to have been experienced at about 6h. 28m., Katmandu time. The motion of the earth was undulatory, as of a large raft floating on the ocean, and the direction of the swell was from North-east towards South-west.

At 10h. 45m., by a good going clock, a second shock occurred, of the same intensity, equal duration, and like character with the preceding. This also was experienced at Calcutta.

The great shock was felt at Katmandu at about 5 minutes to 12 P. M., Calcutta time. It commenced very gradually by a gentle motion of the earth, accompanied by a slight rumbling noise: soon however it increased to a fearful degree, the earth heaved as a ship at sea, the trees waved from their roots, and houses moved to and fro from the perpendicular. Horses and other cattle terrified, broke loose from their stalls, and it was difficult to walk without staggering as a landsman does on ship-board. Dr. Campbell, as an eye-witness, thus describes the scene: "The earth heaved most fearfully, and when the shock was at its worst, we heard the clashing of falling tiles and bricks in every direction: and to add to the impressiveness of the scene, a general shout rose from the people in all directions. The murmur of human prayers was carried audibly from the city to our grounds, (a mile,) and nothing could be more imposing and vast than the whole scene. In a dead calm, the noise of an hundred cannon burst forth: full grown trees bended in all directions, and houses reeled about like drunken men. In our grounds no lives were lost; but in Katmandu 19 persons were buried under the ruins of their own houses, and in the towns of Bhatgaon and Patan, many more." Dr. Campbell's estimate of the duration of this great shock, varies in his letters and memorandum published in the Journal of the Asiatic Society, (Vol. II. p. 439-564). In the former the duration is said to have been one minute, in the latter, three minutes at its fullest force. During the following hour, from 12 to 1 A. M., there were six distinct and strong shocks, the ground in the intervals being scarcely, if at all steady, and from midnight of the 26th to the morning of the 27th, twenty shocks are said to have been felt, while during the whole of the 27th and 28th, the earth was in a constant state of "tremblement."

The comparative intensity of the shock at different points in its course, can only be estimated, in the absence of proper instruments, by its destructive effects on buildings when exposed to its influence. Dr. Campbell has furnished me with materials, which in this point of view are valuable, by having collected accounts in detail of injuries sustained by the various towns throughout the valley of Nepaul, arranging these with reference to their bearing from Katmandu as a central point. This Table I here transcribe:—

Table shewing the number of Lives lost and Buildings destroyed by the Earthquake of the 26th August, 1833.

Places.	Killed.	Wounded.	Houses Destroyed.	Temples and other Buildings.
British Residency grounds,	0	0	1	
City of Katmandu, ..	60	38	400	—Two pillars built by the minister, each upwards of 100 feet high: the large temple of Jagarnáth built by Rau Bahadur, after seven years' labour: and about a dozen temples destroyed.
South of the Capital.				
Patan, ...	6	25	285	—The modern built garden houses of several members of the minister's family have been rendered untenantable: one of them, a handsome and ornamental edifice, has come to the ground.
Sano Gaon, ...	0	0	40	
Harra Siddhi, ...	0	0	20	
Teshu Gaon, ...	0	0	25	
Selli Gaou, ...	0	0	16	
Pagah, ...	0	0	24	
Kuhnah, ...	1	0	130	
Baghmati, ...	0	0	80	—A crack in the ground, 20 feet in length, was observed at this village on the morning of the 27th, the entire number of houses in it was 206, more than a third of the whole were destroyed, and about 100 men (?) have been much damaged.
Phurphing, ...	0	0	8	
Chappa Gaon, ...	0	0	35	
Peang, ...	0	0	8	
Taibu, ...	0	0	18	—The injury sustained here is proportionally greater than at any other part not to the East of Katmandu.
Bara Gaon, ...	0	0	35	
Bali, ...	0	0	3	
Pahon, ...	0	0	3	
Sasanelly, ...	0	0	2	
Lubu, ...	0	0	25	
Sano, ...	0	0	7	
Hills about Sasanelly, ..	0	0	20	
East of Katmandu in the Valley.				
Deo-Patan, ...	3	0	30	—At the eastern extremity of Deo-Patan is the temple of Paspanath, containing Pusputi Jee, the patron deity of the Brahminical inhabitants of Nepaul. The building escaped unhurt, to the great joy of the rulers and people of the land, who attribute the circumstance solely to the interference of the blind goddess in behalf of their favourite god, rather than to the stout deposition of brick and mortar.
Handi Gaon, ...	0	0	20	
Nag Desa, ...	4	0	20	
Bareh, ...	5	0	20	
Tenir, ...	0	0	150	
Gou Karan, ...	0	0	8	
Changu, ...	0	0	20	—A fine old temple destroyed.
Sankhu, ...	20	5	45	—A handsome temple of Mahadeo, situated on a hill above Sankhu, is reduced nearly to ruins.
Bhat Gaon, ...	200	104	2000	—The total number of houses in Bhatgaon is reckoned by Mr. Hodgson at 4700, 3-4ths of the town is said to be destroyed: 2000 is the average of many accounts; six or eight fine temples destroyed, and a statue of Raja Runjit Mall, one of the Newar princes of the Bhatgaon division of the valley.
East of Katmandu beyond the Valley, but in the immediate neighbourhood.				
Sangu, ...	2	0	8	
Baneppa, ...	10	0	20	
Nala Gaon, ...	6	0	11	
Panouti, ...	18	0	19	—Six persons were killed under the ruins of one house in this village: their remains were found where they had gone to sleep.
Dulkele, ...	10	0	21	
Carried over, ..	345	172	3,577	

Places.	Killed.	Wounded.	Houses Destroyed.	Temples and other Buildings.
Brought over, ..	345	172	3,577	
Phulam Chok, ...	60	0	300	—A fine temple destroyed here.
North-East of the Valley, and more remote.				
Dhulaka, ...	..	..	..	—In this direction the Earthquake was much more severely felt. Kuti, a town on the Bhote frontier, on the road to Lassa, is said to have been nearly all destroyed: it contains about 600 houses; 50 of which only remain. At Listigaon, also on the Bhote frontier, a large portion of a hill came down, and an iron bridge was destroyed. —At Kan Sing Chok, in the same direction, vulgar report says, that for four or five days before the Earthquake took place, noises similar to the firing of cannon were heard as if under ground, and in this neighbourhood the high road to Lassa, is said to be in many places blocked up by the fallen earth from the mountains.
Mundun Pahar, ...	..	..	..	
Kan Sing Chok, ...	..	..	..	
Kapa, ...	..	..	..	
Kuti, ...	..	..	..	
Listi Gaon, ...	..	..	..	
Lhipa, the country residence of Colonel Runbir Sinh, 20 miles from Katmandu on the Lapa road, by the Kuti Pass, is seriously injured. Many small houses attached were destroyed and several lives lost.				
West of Katmandu.				
Swambunath, ...	0	0	3	—One small temple destroyed and the large one injured. The form of the large one must have preserved it. It is the chief Buddhist temple in the valley, built in the fashion of that religion, an immense circular mound of brickwork, surmounted by a four-sided spire or jweet.
Hat Chok, ...	0	0	3	
Narod Devi, ...	0	0	1	
Changu Narayan, ..	0	0	2	
Goorkha Cantonment or Campoo, ...	0	0	4	—The house of a Captain much injured here.
Kertipur, ...	0	0	14	—Contains 532 houses, and is built along the ridge and brow of a hill 300 feet higher than the surrounding part of the valley. Its tenements are old and frail. To account for its escape the inhabitants say, "That some nights previous to the Earthquake and on the memorable night itself, a large tiger or leopard paraded several streets of the town, without molesting any of the inhabitants. This forbearance was reciprocal for the 'guardian angel' was allowed to continue his protecting visits: the admiring crowd, firm in the belief of correct vision, hailed him as Ramji, another incarnation of the 'great preserver.'"
Thankote, ...	0	0	23	
West of the Valley.				
Demy Byas and neighbouring Hills, ...	10	0	40	
Tewanpur, ...	0	0	10	
Nayakoth, ...	0	0	3	
North of Katmandu.				
Dhurmtuli, ...	0	0	2	
Huken Gaon, ...	0	0	1	
Toka Gaon, ...	0	0	15	
Burha-tul Kanth, ...	0	0	2	
Chapaly, ...	0	0	7	
Dharmpur, ...	0	0	20	
South of the Valley.				
Chitlong, ...	0	0	14	
Chisagarhy, ...	0	0	0	—The fort here much injured: a large portion of the breastwork facing the South has fallen in, and the wall in many other places, although not fallen, is seriously injured.
Mukwanpur, ...	0	0	0	—The fort here has also suffered, but in a much less degree than the one at Chisapany.
Total, ...	414	172	4,040	

The preceding details establish very distinctly, that toward the North and East of the valley, the disturbing force was much more violent in its action than toward the South and West. In the former direction therefore we are to look for the focus of the shock, and it seems probable, from all the facts recorded, that this was situated among the hills which bound the valley of Nepaul on the North-eastward. As Dr. Campbell's views on this point coincide with my own, I will take advantage of his remarks upon it: "It would appear," he says, "that the most extreme violence of the shock, so far as its occurrence is as yet known, was expended within a tract of country extending from this side of the great Himalayan range on the North, to the course of the Ganges on the South, and from the Arun river (in the Nepaul hills) on the East to the Western branches of the Trisál Ganga on the West, comprising a space of about 200 miles from North to South, and 150 from East to West. In this space, the valley of Nepaul, though not geographically the central point, is most assuredly the portion that has suffered the greatest violence of the calamity," and may therefore be fairly considered as the spot whence the shock emanated.

The intensity of the shock to the North-east of Nepaul, and the direction of its motion, had led Mr. Prinsep, in his notice of the Earthquake, to anticipate intelligence of some fearful catastrophe in the vicinity of Lassa, in Thibet. By a most fortunate coincidence, Dr. Campbell was enabled to collect some information which elucidated this point in an interesting manner. In the notice of the Earthquake by the Secretary to the Asiatic Society, in the Journal for August (1833,) Dr. Campbell remarks: "he expressed a belief that the greatest intensity of the shock would be found to have occurred beyond the Himalayas, in the direction of Lassa:" and judging by the direction from which the shock was felt to have proceeded, and its intensity in the valley of Nepaul, such was the probability, though other has turned out to be the fact, and that upon good authority.

The recent return from Pekin of an Embassy from Nepaul, to the Court of the Celestial Emperor, has furnished authentic information on this subject, which might otherwise have been long wanting: and the whole tenor of it shews, that the great Himalayan range itself, and the country on this (the South) side of it, was alone the theatre of the Earthquake's presence, and that it was not even in the slightest degree felt beyond a very short distance on the Thibetan side of these huge mountains. The embassy was at Lassa on the 26th August, when and where the shock was not experienced. At Digarchi, in the following month, it first received accounts of its occurrence from Nepaul: to the inhabitants of that place the circumstance was however only from reports brought from this side of the mountains: along the road from Digarchi the answer to all enquiries was the same, "no Earthquake on the 26th August," and not until its arrival at Tingri, was it found that the shock had been felt. Tingri is a small Chinese post, immediately beyond the great Himalaya, and the first stage on the table-land (as it is called) of Thibet, going hence to Lassa (by the Kuti or Eastern

Pass from the valley of Nepaul.) From Tingri to Kirung, a distance of 8 or 10 marches, the route is nearly due West, running along and through the Northern side of the Himalaya; and throughout this tract, though but thinly inhabited, authentic reports of the occurrence of the shock were received. By Kirung (the Eastern Pass from the valley into Bhote) the mission penetrated the great range, and at each stage (four in number through the Pass) intelligence of the occurrence was communicated by the few individuals who inhabit that wild and sterile region. But such information was not required, as its effects were sufficiently manifest: in the village of Kirung, itself, supposed to consist of 400 houses, 60 were fairly demolished, and many more seriously injured: two men had been killed under the ruins of their houses, and about a dozen wounded. From the exit of the Pass to Katmandu there are no towns along the route, and scarcely any villages: but at many places, insulated houses of the mountaineers had been thrown down, and the precipitous banks of hills and mountains had been thrown into the subjacent valleys.

Tingri, therefore, in latitude 28° may be fixed upon as the extreme Northern limit of the influence of the shock, and I now proceed to trace its progress in other directions. Before, however, quitting the valley of Nepaul, I may mention as an interesting fact, that torrents of rain fell immediately after the Earthquake, washing down many of the walls which had previously been only shaken.

In tracing the course of the Earthquake to the westward of Nepaul, the diminution of its intensity is remarkably exhibited. At Gorkha, Dr. Campbell mentions, that only two houses were destroyed; at Palpa farther to the Westward, none; and at Dotí on the borders of Kemaon, the shock was felt, but by no means severely. At Lohooghat in Kemaon, Dr. McClelland states, that it was scarcely felt at all, so slightly indeed, that he himself was unconscious of its occurrence, although it was perceived by a friend on whose authority he registered it. In the mountains, therefore, the influence of the Earthquake appears, in so far as shewn by the information recorded, to have extended from the meridian of Lohooghat, about 80° E. to that of Tingri, about 87° E. or over about 7° of longitude. In the plains, however, it extended considerably farther both to East and Westward. In the latter direction, the extreme point appears from the published accounts to have been Delhi, in longitude 77° 16′ E., or nearly 3° farther to the West than Lohooghat. Toward the East, the boundary was the meridian of Chittagong, 91° 42′ E. in the Plains, or nearly 5° to the Eastward of Tingri, which so far as we know, formed the corresponding limit in the mountains. The Southern line appears to have been nearly the parallel of 22° N. latitude. Thus then the entire range of the Earthquake of August 1833, was from between 28° and 29° to 22° North latitude, and from about 77° to 92° East longitude, embracing accordingly 7° of latitude and 15° of longitude; a superficial extent, upwards of four times that of the British Isles, and about twice and a half that of the kingdom of France!

The following summary by James Prinsep, Esq. may appropriately conclude the detail of the Earthquake under review.

"The direction of the vibration was from North-west to South-west: there were three principal shocks; the first about half-past six P. M.; the second at half-past eleven; and the third, or most severe shock, at about five minutes to twelve, Calcutta time. In the places where it was most felt, slight and continued vibrations seem to have been experienced for the whole of the day following. As the time of the second vibration was accurately noted in Calcutta by the stopping of an astronomical clock, we may assume it as the best point of comparison with the times noted at other distant points. Applying the difference of longitude, a few of them may be thus classed:—

		Observed Time.	*Diff. Long.*	*Cal. Time.*	*Effects.*
Katmandu, Nepal,	second shock,	10h. 45*	+ 12m.	= 10h. 57m.	Very severe, with loud noise.
Rungpur,	ditto, ..	.. 11 20	— 2	= 11 18	Many houses injured, loud noise.
Monghyr,	ditto, ..	.. 11 27	+ 7	= 11 34	Walls cracked, noise heard.
Arrah,	ditto, ..	.. 11 15	+ 14	= 11 29	Walls injured, loud noise.
Under Rotas Hills	ditto, ..	.. 11 10	+ 20	= 11 30	
Goruckpur,	ditto, ..	.. 11 20	+ 19	= 11 39	Walls cracked &c.&c.
Allahabad,	ditto, ..	.. 11 0	+ 28 4	= 11 28	Hollow sound from the river.
Bankura,	ditto, ..	.. 11 30	+	= 11 34	None such since 1814.
Calcutta,	ditto, ..	..		= 11 34 48	No injury done.

At Monghyr, Rungpur, Mozuffurpur, Mallai, and other places within direct line of influence, many houses were destroyed or injured, and the alarm was great.

As all comment on the phenomena of this shock is reserved to a future period, I need only now state, that I am not aware of any Earthquakes having occurred in Nepaul since 1833. I ought however before this to have mentioned that in 1829, daily shocks continued to recur for 40 days, although none were equal in intensity to that of the 26th August, 1833. The following Register of the shocks that followed the great one of the 26th was kept at Katmandu by Captain Robinson. Regarding them Dr. Campbell remarks: "Many of them have been severe, and throughout the whole course of these visitations, there have been two distinct varieties observed in the character of the shocks, all those at the commencement were of the undulatory or swinging kind: the others wanted the swell, and were a violent up and down shaking, with little lateral motion. The first may be called the horizontal, the latter the vertical variety. The former alone have been destructive to property, while the latter, from the greater noise by which they are accompanied, and the more rapid oscillations of the ground, are perhaps the more terrifying.

* Time marked by a good going clock, which was stopped by the third shock. Its pendulum vibrated from North to South.

Register of Earthquakes experienced at Katmandu, from 25th August to 26th November, 1833, inclusive.

Date.	Time.	Remarks.
1833.		
Aug. 26th	One at 5h. 55m. P. M. Another at 10h. 50m., 10h. 58m. P. M. was the time the great one commenced, and its duration was 3m.	All of the undulating kind, as well as nine others that occurred during the same night.
,, 27th	4h. 53m. A. M.	Also undulatory.
	5h. 20m. A. M.	
	5h. 26m. A. M.	
,, 28th	7h. 15m. A. M.	Also undulatory.
	4h. 55m. P. M.	
,, 30th	Four shocks: one at 9 A. M.	
,, 31st	Two during the night.	Slight.
Sept. 1st to 11th	Ten shocks.	Slight.
Oct. 4th	7h. 30m. A. M. a smart one, 1m. duration.	This was a severe one, and of the vertical kind: it was felt at Allahabad and Goruckhpur: also at Calcutta.
,, 18th	4h. 55m. P. M. Severe and ushered in with a loud noise.	Same character as last one: was felt slightly at Allahabad: also at Calcutta.
,, 26th	10h. 37m. A. M. Slight.	
Nov. 8th	3h. 55m. A. M. Slight.	
,, 16th	At midnight severe.	
,, 26th	11h. 45m. P. M. Severe.	This was of the up-and-down kind, lasted a minute, occurred at the full moon when the whole people of Nepaul were praying at Paspunath; excited a great commotion, and was the only instance where the prophecies of the Brahmins were realised, although a hundred lucky moments had been determined on for the last three months for the occurrence of shocks.
	In all 39 shocks have been noted, many slight ones have occurred besides.	

I have examined such Meteorological Registers of 1833, as I have been able to procure, with the view of ascertaining whether any indications of atmospheric disturbances accompanying the Earthquake were to be detected, but without success. Such a Register for Nepaul. I have not however been able to procure, and I regret it, since it was there, as the seat of the Earthquaking force, that the disturbances might have been most confidently anticipated. Although torrents of rain fell in the valley, the Rain Guage at Calcutta on the same day is recorded as empty.

With the physical structure of the valley of Nepaul I am not acquainted, nor have I found any trust-worthy account of its geology, or that of the adjoining mountains. Colonel Kirkpatrick, in his Work on Nepaul, states, (p. 177), "With regard to volcanoes, although I met with no traces of any in our route, yet it is certain that there are some eruptions to the Westward; but whether these arise merely from bituminous or other inflammable substances, or are actually volcanic,

I am unable to determine." These may possibly be the mere local action, but they are interesting as maintaining, the analogy between Nepaul and the other valleys of the lateral Himalayan Tract, where like phenomena have been found to prevail. Perhaps they may be similar in character to the burning ground of Cashmere.

E. Earthquakes of the Valley of Assam.

Although Earthquakes would seem to be by no means unusual occurrences in the valley of Assam, it is not until the year 1842 that any have been actually recorded; or if otherwise, notices of them have hitherto escaped me. Two shocks which may be traced to the valley, are noted in my Register for 1842, the first on the 23rd, the second on the 29th October, and these form the only primary shocks observed, the others by which the valley was affected during that year being evidently secondary ones, emanating from other points.

The indications of powerful volcanic action throughout Assam are numerous. The Kasyá Hills on the South-west, present some of the most remarkable phenomena of upheavement to be found perhaps in the world: coal is found elevated to a height of 4,300 feet above the level of the sea, on the summit of a mountain at Chirra Poonjee, accompanied by a series of rocks precisely similar to those associated with the coal at the base of the same hill; at the same place, a fossil Beach was discovered by Dr. McClelland, the precise height of which I do not at this moment recollect, but think it was about 1,500, or. 2,000 feet; igneous rocks are so largely distributed in such positions, as to indicate their having been the causes of the upheavements in question. In the Naga Hills on the South and South-east, hot springs occur, the temperature of one of which was found to be $110\frac{1}{2}°$ by Lieutenant Bigge, (J. A. S. Vol. X. p. 132); throughout the valley similar springs with others of petroleum and naptha are numerous, all indicating a tract where volcanic forces are now in operation, and whence Earthquakes may consequently be expected to emanate. I am not acquainted with the physical structure of the Singhpo and Mishmee Hills on the Eastward, but I have little doubt similar volcanic indications would be found there as elsewhere, as from this quarter it is the impression throughout the province, shocks most commonly proceed.*

The record of the Earthquakes of the lateral Himalayan Tract is now completed, and in order to exhibit a general view of the whole, I have compiled the following Table:—

* I regret much that the following details of Earthquakes in Assam, should not have reached me in time to be included in the body of this memoir. I am indebted for them to Major Jenkins, Governor General's Agent in Assam, Mr. Masters, and to Mr. Piddington, by whom a copy of Capt. Hannay's memorandum was forwarded to me. I have combined the whole of the materials received, and formed from them a general list of Assam Earthquakes, omitting those however of 1843, as the Register for that year is not yet prepared.

The earliest is recorded by Capt. Hannay as having occurred on the 14th January 1839. It was felt at Suddeah, and its direction was, so far as could be ascertained, from S. W. to N. E. Some days of heavy rain in the valley, and snow in the mountains, preceded it.

3d June, 1839.—An Earthquake experienced at Suddeah on this date, apparently from South to North. Severe storms with a N. E. wind. Burrampooter high, and the weather

Tabular view of the Earthquakes of the lateral Himalayan Tract.

Focal Districts.	Number of Earthquakes.	Date of Earthquake.	Remarks.
A. Valley of Cabool.			
	1	A. D. 1505,	Very severe, affected the whole of Affghanistan.
	2	,, 1829,	Severe.
	3	,, 1836,	Several shocks experienced by Mr. Vigne, all slight.
	4	14th Dec. 37,	Three shocks noted by Sir A. Burnes, slight.
B. Valley of Jellalabad.			
	5	19th Feb. 42,	Very severe, affected the whole line of the valley of the Cabool River, the plains of the Punjaub, and a portion of the N. W. Provinces of India.
From February to June 1842, not less than 200 shocks in all, must have been experienced throughout the valley, in which Earthquakes have long been common occurrences, especially during the cold weather.	6	22d Feb. 42,	Shocks all night and day with little intermission.
	7	23d Ditto,	Ditto ditto, some severe.
	8	24th Ditto,	A few shocks, gentle. Earth in a tremulous state.
	9	3rd Mar. 42,	Several shocks, smart.
	10	20th Ap. 42,	Severe, preceded by heavy rain and high temperature.
	11	4th June 42,	Slight.
	12	10th Ditto,	Smart.
	13	29th Ditto,	Slight.
C. Valley of Cashmere.			
	14	A. D. 1552,	
During the Earthquake of 1828, if all the shocks are taken into account their number must have exceeded 10,000! !	15	,, 1780,	Severe.
	16	6th June 1828,	Very severe for two months, afterwards shocks to the amount of nearly 200 daily were experienced. The cessation of shocks followed by Cholera.
	17	,, 1831-32,	? Shocks said to have continued for six months. Recorded by Sir A. Burnes from native information. This cessation is probably the same as the preceding, a mistake as to time having been made.
D. Valley of Nepaul.			
	18	A. D. 1830,	? Very severe. Recorded in the Sacred Books of the Nepaulese Brahmins.
N. B.—The minor shocks of the lateral Himalayan Tracts have been continued for so many ages, that any attempt to approximate to their total number would be useless: yet the number of distinct shocks *indicated* in the above Table cannot be estimated at less than about 12 or 15,000!	19	,. 1829.	Smart shocks daily for 40 days.
	20	26th Aug. 33	Very severe. Affected a large portion of the Himalayas and the Plains of India from Delhi to the Bay of Bengal.
	21 to 57	From Aug. to November 1833.	Thirty-six shocks from 27th August to 26th November.

weather wet and disagreeable. Capt. Hannay remarks, that from March to June, the season was unusually rainy, and that although he does not distinctly recollect the periods, four shocks of Earthquake were felt at Suddeah in 1839.

14th January, 1840.—At 6 A. M. on this day, two shocks were experienced by Mr. Masters at Nazera (?) in Upper Assam.

3d February, 1840.—Another felt by the same observer, at the same place.

4th March 1840.

3.—*Earthquakes of the Tract of the Solimaun Mountains.*

This tract cannot yet be considered as well established, since I have found but one Earthquake that can be referred to it, and this not with perfect confidence. The shock occurred in 1831, and was very severe.* It extended from Peshawur to Dhera Ghazee Khan, but the point of greatest force was in the vicinity of the village of Derabund, on the Eastern slope or side of the Solimaun range. Near this spot it is said, that water appeared from crevices formed in the plan: men and camels were unable to stand from the violence of the undulations, and fragments of rock fell in many places among the mountains.

Very little information connected with the physical structure of the Solimaun range has come under my notice, and I am unable to say whether the usual indications of volcanic action exist there or not. Mr. Vigne mentions, (Travels in Affghanistan, p. 61,) his having procured from the interior of the mountains, specimens of a substance which on analysis appeared to be naptha with bituminous matter in solution. It oozes through the ground in various parts, and as it is a very common product of volcanic regions, it may indicate in the present case, volcanic action in some portions at least of the Solimaun mountains.

4.—*Earthquakes of the Tract of the Aravulli Mountains.*

It is only to the Northern portion of the Aravulli range, extending from the latitude of Agra to that of Delhi, that Earthquakes can yet be traced. The earliest of which I have discovered any notice is that of the 15*th July* 1505, experienced at Agra, and recorded in Dow's Ferishta, (Vol. II, p. 75). With indications of oriental exaggeration it is there stated, that "the mountains shook on their broad bases, and every lofty building was levelled with the ground, some thousands being buried in the ruins." Making due allowance for the tendencies of native historians in general, and of Ferishta in particular, this shock still appears to have been a severe one, and it is remarkable, that it was

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4*th March*, 1840.—A shock was felt this day by Capt. Hannay, shortly after a total Eclipse of the sun. He remarks, when the sun was obscured the air was unusually cold and disagreeable to the feelings, even to nausea: about an hour after the Eclipse passed away, *i. e.* about 1 P. M., a smart shock of an Earthquake, and about ten minutes afterwards another: both shocks appeared to have come from the South. The sky was cloudless, but the atmosphere hazy.

9*th February*, 1841.—An Earthquake at Gowhatty this day (or on the 11th). Capt. Hannay states, that it was different to those previously mentioned. It was accompanied by a low rumbling noise, was sharp and stunning, as if a blow had been struck under you: the others alluded to, appear to have more of a trembling or rocking motion.

12*th October*, 1841.—A slight shock recorded by Mr. Masters at Nazera. Time 6 A. M.

4*th January*, 1842.—A smart shock felt on this day at 7½ P. M., at Sibsagur. The weather gloomy, cold and threatening rain. Capt. Hannay is unable to specify the direction, but the motion was of the undulatory character.

4*th February* 1842.—At 8 A. M., a shock experienced at Nazera by Mr. Masters.

The other shocks of 1842 are duly noted in the Register for that year. Those for 1843 shall be given in due time.

Any remarks on these shocks will be given more appropriately hereafter, and I may now only express my obligations to the gentlemen who have so kindly forwarded their notes to me.

* Vigne's Travels in Affghanistan, vol. i, p. 58.

during this same year that the Earthquaking forces were so fatally active throughout Affghanistan, as described in a former page.

The next Earthquake in order of time, which is referrible to the Aravulli tract is that of *July*, (day not ascertained,) 1720, experienced at Delhi. It occurred in the reign of Mahommed Shah, and during the troubles that prevailed while the two *Seiad* brothers, Abdullah Khan and Hosein Ali Khan, usurped the functions of the imperial Government. It is referred to only incidentally by Mr. Elphinstone in his History of India, (Vol. II, p. 586), while narrating the defeat, on several occasions, of the imperial troops by those of Asof Jáh, the founder of the sovereignty of the Nizams of the Deccan. "These events," Mr. Elphinstone remarks, "threw the *Seiads* into consternation, and though secretly agreeable to the emperor and many of the nobility, filled the minds of reflecting men with dismal forebodings of the ruin of the Empire. This gloom was rendered deeper among a superstitious people by a violent Earthquake which occurred about this time, and seemed to threaten the existence of the capital: and in these depressing circumstances, the brothers betrayed those signs of irresolution which are often the fore-runners of great calamities." There is now pointed out in Delhi a mosque, one of the minars of which, (still unrepaired,) is traditionally said to have been thrown down by an Earthquake which occurred in the early part of last century, possibly by that now under notice. Mr. Elphinstone also mentions, that the beautiful column, called the Cuttub Minar, situated about 12 miles from modern Delhi, lost its upper portion from the effects of an Earthquake, but no clue to the date of this accident is given. (Elphin. Hist. Vol. II, p. 9).

An interval of upwards of a century now intervenes ere another Earthquake in this tract is recorded; and relative to those which follow, the general remark may be made, that their intensity is very much inferior to those just noticed. They are far too slight to have even produced any effect on buildings of masonry, and have been almost universally nothing more than slight undulations of the earth, accompanied by noises. They could produce neither the moral nor physical effects attributed to the shocks of 1505 and 1720, and it would therefore appear, that since the last mentioned date, the disturbing forces have materially decreased in violence.

Earthquake of the 24th October, 1831.—This Earthquake was experienced near Delhi, and is described in the following letter published in the "Gleanings of Science," (Vol. III. p. 388,):—

To the Editor of the "Gleanings of Science."

Near Delhi, 24th October, 1831.

Sir,—I beg leave to send you a short account of a smart shock of Earthquake which occurred in my neighbourhood on the 24th October at half-past noon. I am encamped in North latitude 28° 34′ and longitude 78° 04′ 26″ East from Greenwich. The wind was West from which quarter it had been blowing steadily for some days, but just previous

to the Earthquake, was in strong gusts. The horizon was hazy, but there were no clouds, and no noise was heard: the motion was apparently perpendicular, and if any thing from the North to the South. It continued for a full minute, and was the most severe many persons say, they ever felt. Books moved from their places on the table, the tent was literally shaken, and the mangoe trees appeared as violently agitated as if a branch had been seized and shaken for the purpose of throwing off the fruit: a palanquin in the tent moved, and it was with difficulty we could stand on the ground. My bearer actually laid hold of the *kanát* of the tent, and every one became sick, as if he had been at sea: but the most extraordinary circumstance is, that though the Earthquake was equally strong and perceptibly felt to the Southward, none of my parties who were detached to the Northward three or four miles felt it. The shock was so strong and continued, that I sent to a village, distant about a quarter of a mile, to know if any accident had happened, and was informed, that although the people were much alarmed, no damage was sustained. * * * * * * * * *.

B.

P.S.—Since writing the above, I have heard that at a large village called Khanpùr, three miles South-west of this, the people ran out of their houses for fear of their tumbling down, and some stones fell from the Northern gate.

The observer in this case was situated considerably to the Westward of Delhi, and judging from the circumstances detailed, near to the Northern limit of the shock. Southward from the position the intensity was greater, but the Southern limit is undefined. From other evidence I have stated my conviction to be, that the local Delhi shocks have their focus in the Aravulli mountains, about twenty or thirty miles South-west of that city, and the details connected with the present shock, lead me to believe it emanated from the same locality. The line of greatest intensity would then be to the Southward of the observer, as it actually was, and although the direction of the motion seemed to be from North to South, while it ought, on the above supposition, to be from South-west to North-east, yet as the observer writes with hesitation on this point, he may very possibly have been mistaken. My own opinion certainly is, that the Earthquake of the 24th October 1831, emanated from the Aravulli range, and was a primary, although a local, and by no means, a widely extended shock.

For upwards of ten years another blank occurs, during which, no Earthquakes of the Aravulli tract are recorded. During the year 1842, no less than eight were experienced, as noted in Part I of this Memoir, so that the disturbing forces must have been unusually active in that year, unless their previous inactivity may be due only to our want of information on the subject, a circumstance by no means improbable. As I have noted all details relative to the shocks of 1842 in the Register, I need only recapitulate their dates here, combining with them, the others of the tract, so as to give the whole at one view:—

Tabular view of the Earthquakes of the Aravulli Tract.

Focal Tract.	Number of Earthquakes.	Date of Earthquake.	Remarks.
Aravulli Mountains, from about 27° to about 28½° North latitude.	1	15th July, 1505,	Very severe. Experienced at Agra.
	2	Ditto,.... 1720,	Very severe. Experienced at Delhi.
	3	24th Oct. 1831,	Smart.
	4	4th Jan... 1842,	Slight.
	5	Ditto, .. ,,	Ditto.
	6	4th July, ,,?	Ditto.
	7	25th Ditto, ,,	Ditto.
	8	26th Sept. ,,	Ditto.
	9	27th Ditto, ,,	Ditto.
	10	6th Nov. ,,	Ditto.

I have already mentioned in Part I, that indications of active volcanic forces are found in that portion of the Aravulli Hills now under notice; but our information relative to the general structure of the range is as yet very meagre, so much so, as not to warrant me in dwelling on the subject, and I therefore pass on to narrate the Earthquakes of the next tract.

5.—*Earthquakes of the Delta of the Indus.*

From the numerous volcanic phenomena presented throughout the tracts of country bordering on, and forming the Delta of the Indus, the frequent occurrence of Earthquake shocks might have been anticipated, but it is not until the year 1819 that any have been recorded, so far as I have yet ascertained. The various circumstances attending the great shock of the 16th June 1819, have already been ably brought before the scientific public by different authors, and a careful analysis of the whole has been made by Mr. Lyell in his "Principles of Geology, Chapter XIV." Since it is my object to present in this memoir a complete view of Indian Earthquakes, in so far as existing information will permit, it is necessary that I should repeat the accounts already given, and it is my intention to do so, in as full detail as the various published notices will admit of.

We have no accounts of the effects of this Earthquake at any point farther Westward than in the province of Cutch, although from its violence, it is probable, that it extended to Sinde and Mekran. Commencing however with Cutch, its course will be traced Eastward, and its effects at various spots detailed.

Cutch.—The greatest force of the Earthquake under notice, appears certainly to have been exerted within the province of Cutch. Nearly every town and fort in it were seriously injured, many levelled with the ground, and among their ruins numerous lives were lost. The first and greatest shock occurred at a few minutes before 7 P. M. on the 16th June, but shocks of inferior violence continued until the 20th, when the volcano called *Denodur*, situated thirty miles North-west

from Bhooj, the capital of Cutch, burst into action, and the movements of the earth immediately stopped.

The effects of the shock in the Western portion of the province were remarkable and severe. An extensive subsidence of the Delta of the Indus took place, which is thus described by Mr. Lyell, on the authority of Captain Macmurdo: "Although the ruin of towns was great, the face of nature in the inland country was, not visibly altered. In the hills, some large masses only of rock and soil were detached from the precipices: but the Eastern and almost deserted channel of the Indus, which bounds the province of Cutch, (on the Westward,) was greatly changed. The estuary or inlet of the sea was before the Earthquake, fordable at Luckput, being only about a foot deep when the tide was at ebb, and at flood tide never more than six feet; but it was deepened at the fort of Luckput after the shock to more than eighteen feet at low water. On sounding other parts of the channel it was found, that where previously the depth of water at flood never exceeded one or two feet, it had become from four to ten feet deep. By these and other remarkable changes of level, a part of the inland navigation of that country, which had been closed for centuries, became again practicable." In describing the effects of the shock in this neighbourhood, Captain Burnes remarks: (Travels, Vol. I. p. 311.) "Wells and rivulets without number changed from fresh to salt water: but these were trifling alterations compared with those which took place in the Eastern branch of the Indus and the adjacent country. At sun-set, the shock was felt at Sindree, the station at which the Cutch government levied their customs, situated on the high road from Cutch to Sinde, and on the banks of what had once been the Eastern branch of the Indus. The little brick fort of 150 feet square, which had been built there for the protection of merchandise, was overwhelmed by an inundating torrent of water from the ocean, which spread on every side, and in the course of a few hours converted the tract, which before had been hard and dry, into an inland lake, which extended sixteen miles on either side of Sindree. The houses within the walls filled with water, and eight years afterwards, I found fish in the pools of water among them. The only dry spot was where the bricks had fallen upon one another. One of the four towers only remained, and the Custom House Officers had saved their lives by ascending it, and were eventually transported to dry land by boats on the following day."

"But it was soon discovered," Captain Burnes continues, "that this was not the only alteration in this memorable convulsion of nature: as the inhabitants of Sindree observed at a distance of five miles Northward, a mound of earth or sand, in a place where the soil was previously low and level. It extended East and West for a considerable distance, and passed immediately across the channel of the Indus, separating as it were for ever, the Phurraun river from the sea. The natives called this mound by the name of "Ullah Bund," or the Mound of God, in allusion to its not being like the other dams of the Indus, a work of man, but a dam thrown up by nature."

This remarkable bund was cut through by a great inundation of the Indus, and from the section thus exposed, it was found to be composed of clay and shells. "To the eye," Captain Burnes remarks, "it did not appear more elevated in one place than another, and could be traced East and West as far as it could reach: the natives assigned to it a total length of 50 miles. It must not, however, be supposed to be a narrow strip like an artificial dam, as it extends inland to Raomoka Bazaar, perhaps to a breadth of sixteen miles, and appeared to be a great upheaving of nature. Its surface was covered with saline soil, and I have already stated, that it consisted of clay, sand and shells."

Thus at the Western extremity of Cutch, the effect of the Earthquake of 1819 was to produce simultaneously an elevation of a tract of country, fifty miles in length, sixteen miles in breadth, and ten feet in height, and a depression of another tract extending over about 2,000 square miles, which latter became an inland lake or lagoon. The depth of the channel of the river was variously affected, at some spots becoming greater, at others less, but all indicating material changes of level throughout the tract.

Runn of Cutch.—This remarkable tract of country extends from the Indus to the Western confines of Gujerat, having a total superficial extent of about 7,000 square miles. During the Earthquake, numerous jets of black muddy water were thrown out from fissures throughout this region, and cones of sand, six and eight feet high, similar in character to those observed during the Chilian and Italian Earthquakes, were thrown up. It is traditionally reported, that the Runn of Cutch was formerly an inland sea, freely accessible from the main ocean; that an extensive commerce was carried on along its shores; and that many towns, now far inland, formed its harbours. Nerona, a village about twenty miles N. N. W. from Bhooj and Chanu westward of Nerona, are both said to have been sea-ports. The people of Puchum, the largest island in the Runn, have traditions of boats having been wrecked on the hills of the island, and they point out several considerable harbours, called Dorut, Doh, or Dohee and Phungwuro, to the westward of Puchum. On the Sinde, or western side of the Runn, like traditions prevail. In farther confirmation of these traditionary accounts, it was observed, that during the shock of 1819, numerous pieces of iron and ship nails were thrown up with the black muddy water near Phungwuro, and like materials have subsequently been discovered in digging tanks in the neighbourhood. The traditions of the inhabitants of Cutch indicate the cause of this change of sea to land to have been some great natural convulsion, and they have, as is usual among a superstitious people, connected the occurrence with a mythological legend. A Hindoo saint, by name Dhoorumnath, a Jogee, (Burnes' Travels, Vol. I. p. 319), underwent penance by standing on his head for twelve years on the summit of Denodur, one of the highest hills in Cutch, overlooking the Runn. At the close of his penance God appeared to him, the hill on which he stood split in two, and the present Runn dried up, the ships and boats then navigating

its waters were overturned, its harbours destroyed, and the existing waste of land substituted for the pre-existing waters. It is thus that barbarous nations preserve the memories of great physical events, while they are incompetent to form any written record of their occurrence; and in such traditions, although interwoven with circumstances sometimes impossible, sometimes absurd, there is usually a substratum of actual truth. In the present case, "considering the frequent occurrence of Earthquakes in Cutch, the volcanic appearance of the hills and lava which covers the face of the country," there can be but little doubt, that a great alteration of level took place throughout the Runn, in consequence of some great convulsion, the existence of which is indicated only by the legends above referred to.

Bhooj.—Lat. 23° 15′ N., long. 62° 59′ E. At Bhooj, the capital of Cutch, the destructive effects of the Earthquake of 1819, were very great. They are thus described by Prof. Jameson, (History of India, Cab. Library, Vol. III. p. 270.) "The first and greatest shock took place on the 16th June 1819, a few minutes before 7 P. M. The wretched inhabitants of Bhooj were seen flying in all directions to escape from their falling habitations. A heavy appalling noise, the violent undulatory motion of the ground, the crash of the buildings, and the dismay and terror which appeared in every countenance, produced a fearful sensation beyond description. The shock lasted from two to three minutes, in which short period, the city of Bhooj was almost levelled to the ground. The walls, from the sandy nature of the stone, were crumbled into dust; nearly all the towers and gateways were demolished; and the houses left standing were so shattered, as to be uninhabitable. It was calculated that nearly 2,000 persons perished at Bhooj alone." "In the British camp, which was pitched in a plain between the fort and city of Bhooj, the general feeling was an unpleasant giddiness of the head and sickness of stomach, from the heaving of the ground; and during the time the shock lasted, some sat down instinctively, and others threw themselves on the ground. Those who were on horseback, were obliged to dismount; the earth shook so violently, that the horses could with difficulty keep their feet; and the riders, when on the ground, were scarcely able to stand."

Ahmedabad.—Lat. 23° 1′ N., long. 72° 42′ E. At this city, the chief town of Gujerat, the shock was very severely felt. The following description of its effects is given in the work above quoted: "This city is justly celebrated for its beautiful buildings of stone and other materials, and for the famous shaking minarets which were admired by every stranger. Alas! the devastation caused by this commotion of the earth is truly lamentable. The proud spires of the great mosque erected by Sultan Ahmed, which have stood nearly 450 years, have tumbled to the ground within a few yards of the spot where they once reared their heads. Another mosque of elegant structure which lies to the left of the road leading to Shahee Bagh, has shared the same fate. The magnificent towers, which formed the grand entrance into the

citadel have been much shaken, and cracked in several places. The fort and town of Jelelsheer are reduced to ruins. Many of the people killed were already out of doors, which is usually considered a situation of comparative safety. A marriage was about to be celebrated in a rich man's family, and the castes had assembled from various different quarters: the shock occurred when they were feasting in the streets, and upwards of 500 of the party were killed among the ruins of the falling houses." "All the disagreeable sensations were experienced of being tossed in a ship at sea in a swell, and the rocking was so great, that every moment we expected the earth to open under our feet."

Surat.—Lat. 21° 11′ N., long. 73° 7′ E. The Earthquake at Surat is thus described by an eye-witness: "The vibration of the couch on which I was lying was so great, that I was glad to get off it; the house was considerably agitated, the furniture all in motion; a small table close to me kept striking the wall, and the lamps swung violently. I ran down-stairs, and got out of my house as fast as possible. On getting outside I found a number of people collected, gazing with astonishment at my house, which stands alone, and was so violently agitated, that I expected it to fall down. The earth was convulsed under our feet."

Baroach.—Lat. 21° 46′ N., long. 73° 14′ E. At this place the violence of the shock was very considerable. "Such of the houses as are elevated," says an observer who was on the spot, "and at all loosely built, creaked like the mast and rigging of a ship in a gale: venetians and window frames rattling violently and the buildings threatening immediately to fall: a considerable lateral motion was impressed on every thing that admitted of it. After this, more violent concussion had lasted a minute or upwards, it was succeeded by an oscillatory motion, of a more equable character, which continued for more than a minute and a half, making the whole period of the convulsion nearer three than two and a half minutes."*

* I am indebted to H. Piddington, Esq. for the following additional details of the great Earthquake of June 1819. In common with other interesting communications previously alluded to, it arrived too late to be inserted in the body of my paper, and I am accordingly constrained to give it in this form:—

Extract from the Asiatic Journal, Vol. IX, 1820, *p.* 164.

Observations made at Porebunder, (lat. 21° 39′ N., long. 69° 45′ E.) Since the 17th of June 1819, regarding the Earthquake.

It is necessary to state that these notes of the subsequent phenomena, were communicated in a letter to a literary friend in India, which will account for the familiar style of the remarks and the local allusions.

18*th June.*—Thermometer at 2 P. M. 90°; wind light at S. W. Large electric clouds approaching from all quarters: vegetation much advanced. Neither shock nor tremors in the Earth, but in the person, a giddy and slight sickish or faint feel with pains in the knees, and an inclination to lie down on the earth rather than sit or stand, and cannot apply myself to any thing. These feelings appear to be general.

19*th.*—Thermometer at 2 P. M. 90°, cloudy; wind light S. W. by S. A tremor in the Earth at midnight, but of too short duration to allow of quitting the bed. The same unpleasant personal feelings all day and night as on the 18th: feel relieved by lying down, particularly on the earth.

20*th.*—Thermometer at 2 P. M. 90°; wind S. W. A sensible tremor at noon: repeated at 50 minutes afterwards. The same disagreeable feel as on the 18th.

21*st.*—Thermometer at 2 P. M. 90°; slight breeze at S. W. by S. Felt a continued tremor of the earth at midnight while in bed: removed from bed and slept in the open air, lest other shocks should bring down a shaken house.

22*nd.*

The extreme eastern limit of the Earthquake of 1819, appears to have been Poonah, where its force was only very feebly experienced. The tract affected therefore extends, so far as existing information shows, from about the meridian of 69° to that of 74° East longitude, and from about 18° to 24° North latitude. These limits are, however, by no means well ascertained, especially to the westward of Cutch, and also to the northward; our information from both of these directions being deficient.

22*nd*.—Thermometer at 2 P. M. 88°; wind West. Weather changed to a gloomy, cloudy appearance, with indications of rain. Less tremor of the earth, but a consciousness that I am rather in a long rocking motion than standing firm; when I walk I do not think I go strait. The same unpleasant sensation as on the 18th, though in a less degree: from this and the change in the weather, entertain hopes that the tremors are ceasing, and that we shall soon be quit of our alarms and unpleasant feelings.

23*rd*.—Thermometer at 2 P. M. 82°; wind S. S. W. Our first rains set in strongly at 12 last night, with the change of the moon: there were three tremors of the earth, but to-day our personal disagreeable sensations have abated, and we trust and hope that with the change of season, all physical effects of the Earthquake are leaving us for ever.

24*th*.—Thermometer at 2 P. M. 82°; wind high S. S. W. Rough monsoon weather; much rain. Notwithstanding our hopes of yesterday, we were again alarmed last night between 12 and 1 o'clock, not by a tremor but by a shock, which awakening us, caused us to jump out of our beds and run into the open air, where we remained an hour. The shock lasted about two seconds. Immediately after it, observed a long narrow black cloud, running west and east, or quite the reverse way to what I am accustomed to see a line of cloud extend: it appeared stationary for half an hour, during which period there were constant tremors in the earth. Some houses in the town were thrown down. Our knees ached for half an hour after the shock: but on the whole we are much relieved from the disagreeable sensations of lassitude, giddiness and faintishness which we have constantly experienced since the great shock of the 16th. I attribute the sickish feel to the rocking motion we were constantly subject to. We were confident that the earth was in a long rocking or rolling motion, though we could not observe it.

25*th*.—Thermometer at 2 P. M. 82°; wind light at S. S. W. no rain. There was neither shock nor tremor last night. I never experienced so charming a star-light night. I was up at 12, expecting a shock, and found the heavens so clear, and the stars so numerous and bright, that I was inclined to imagine, the Earthquake had swept the atmosphere of all its impurities. At present we are quite free from our late unpleasant feelings, and as the springs will be over to-day, so do I trust will all future shocks and tremors of the earth. At 2 P. M. heard at a considerable distance, in an easterly direction, about eight distinct sounds, like the discharge of cannon. I expect to hear of the bursting of one or more volcanoes in that direction. This being the end of the springs, though I know not that they influence Earthquakes, yet I think it probable they do, and hence imagine that the disorder in the bowels of the Earth, arriving with the springs, at a crisis, will cease with the discharge it has found for its foul air, and that now, you as well as ourselves, will be left at rest and hear no more of Earthquakes.

But a remark or two before I bid adieu. Certainly the commencement of the late phenomena had no connection with the springs, neither has that of a fever in the human frame, yet its crisis is always affected and frequently determined by them (?). I allude to the effects of the springs on fevers, beneath the tropic in particular, where the sameness of the atmosphere, causes them to act with greater influence on all physical matter than beneath more variable latitudes. The late phenomena has brought to my recollection, my having observed to an Officer of the Marine about the beginning of March last, that "there was a cloud in the North-east, which appeared uncommonly charged with electric matter." Its direction was nearly opposite to the one from which I heard the sound that preceded the great shock of the 16th. I have observed that previous to the approach of the S. W. monsoon, the electric clouds first appear in the N. E. on the opposite direction to that of the monsoon. Earthquakes are said almost always to be preceded by great droughts, but not so with that of the 16th. It was preceded by the usual hot season, but not by any uncommon drought. You will recollect, that in 1812 we had an uncommon drought in this country, so that many thousand of the inhabitants died for want of food, and the cattle for grass; but it was

Indications of active volcanic action are very numerous throughout the Delta of the Indus, and indeed along the entire range of the coast of the Arabian Gulf. Hot springs are numerous among the mountains which fringe the Delta, and to the eastward volcanic phenomena are remarkably developed. I am indebted to an interesting paper on the country between Kurachee and Hinglaj, by Captain Hart, 2nd Bombay Grenadiers, for the following account of a singular series of mud volcanoes in a low range of hills to the eastward of the greater Hara mountains: "Six miles beyond the Phor river," Captain Hart remarks, "we came to the Tilookpoore wells, at present covered with an extensive marsh of fresh water formed by the late rain. One coss from them, in a westerly direction, three hills of extremely light coloured earth rise abruptly from the plain. That in the centre is about four hundred feet in length, of a conical form, with the apex flattened and discoloured: its southern and western farces rather precipitous, and with a more gradual slope on the others. It is connected with a

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was not followed hy an Earthquake! I have observed that the tremors and shocks have invariahly been most constant and strong at 10 A. M. at noon, and at midnight. There has been no occurrence worthy of observation since the 25th, and as this is now the 30th, my conjecture of the former date has been so far correct, that the principal effects of the Earthquake did subside with the springs. The sensations felt since the 25th have been so slight, that were it not for their being somewhat generally acknowledged, they might he taken for the effects of the imagination."

The personal sensations alluded to ahove as felt before and during the Earthquake shocks, are identical in character with those invariably experienced by the writer before and during a thunder-storm. The same lassitude, feeling of sickness, and oppression are felt by me when tbe air is unusually charged with electric matter. I note the circumstance, because it is one of several, which indicate a connection between Earthquakes and tbe electric condition of the atmosphere.

The following observations would lead to a material extension of the extreme limits of the shock of June, 1819, since tbey prove that its influence extended even beyond the Ganges, affecting the whole of the country between that River and tbe Indus:—

Extract from the Asiatic Journal, Vol. IX. p. 184.

Muttra.—June 19th 1819. We had a smart shock of Earthquake here on the evening of the 16th, between 7 and 8 o'clock, which lasted I should imagine about 30 or 40 seconds.

Chunar and Mirzapore.—About 8 o'clock in the evening of the 16th June, the shock of an Earthquake was experienced at these places. At Chunar the motion was accompanied hy a noise in tbe atmospbere, which resembled that occasioned by the rapid flight of birds.

Mynpooree.—June 20. On the evening of the 16th, we had a slight shock of an Earthquake: the undulating motion continued little more than a minute, and seemed to come from the West. It was felt very nearly at the same time at Futteyghur, and at one of my police chokees across the Jumna.

Jounpoor.—A strong shock of an Earthquake was felt here on the night of the 16th of June, at a quarter past eight o'clock: there were three distinct vibrations from West to East, with the usual accompaniments of rattling wall-shades, swinging punkahs, which appeared to me about 25 seconds: the intervals were very distinct. It was not accompanied by the rumhling noise I have usually heard on such occasions, and which I have hitherto imagined to be the earth's vihration. Both the noise and motion must he separate effects of some unknown cause. The rains have not yet commenced and the weather has been unusually hot.

Sultanpore, Oude.—June 17. A severe and awful shock of an Earthquake was felt at this station last night at 17 minutes past eight, which lasted some time, and occasioned very considerable alarm. The bungalows actually rocked, particularly the Mess one of the 1st Bat. 19th Regt., in which the officers were at dinner at the time, and the huts of the soldiers were a good deal damaged. Tbe heat for the last two or three days has been excessive, and not a drop of rain has yet fallen.

smaller one of the same form, but of not more than half its size, by a sort of causeway, some fifty paces in length. The third bears the appearance of a cone, having been depressed and broken, and covers a greater extent of ground than the others. All three towards their bases are indented by numerous cavities which reach far into the interior: their sides are streaked with channels, as if water had flowed from them. On ascending the summit of the highest one, I observed a basin of liquid mud, about one hundred paces in circumference, occupying its entire crest. Near the southern edge, at intervals of a quarter of a minute, a few small bubbles appeared on the surface: that part of the mass was then gently heaved up, and a jet of liquid mud, about a foot in diameter, rose to that height, accompanied by a slight bubbling noise. Another heave followed, and three jets rose; but the third time only two. They were not of a magnitude sufficient to disturb the whole surface, the mud of which at a distance from the eruption was of a thicker consistency than where it took place. The pathway round the edge was slippery and unsafe, from its being quite saturated with moisture, which gives the top a dark coloured appearance; on the southern side a channel, a few feet in breadth, was quite wet from the eruption having recently flowed down. I was told that every *Monday*, the jets rose with greater rapidity than at other times, and then only did any of the mass ooze out of the basin. The entire coating of the hill appears to be composed of this mud, baked by the sun to hardness. No stones are to be found on it, but near the base, I picked up a few pieces of quartz. Crossing the ridge which connects this hill with the least of the three, I climbed up its rather steep side. In height or compass it is not half the height of its neighbour, and its basin, which is full of the same liquid mud, cannot be more than five and twenty paces in diameter: the edge is so narrow and broken, that I did not attempt to walk round it. One jet only rose on its surface, but not more than an inch in height or breadth: but a very small portion of the mass was disturbed by its action, and although the plain below bore evident marks of having been once deluged to a short distance by its stream, no eruption had apparently taken place for some years. At times, the surface of this pool sinks almost to the level of the surface of the plain, at others it rises so as to overflow its basin: but generally, it remains in the quiescent state, in which I saw it: two years previous, it was many feet below the crest of the basin. On my way to the third hill, I passed over a flat of a few hundred yards, which divides it from the other two. The sides are much more furrowed by fissures than theirs are, although their depth is less: and its crest is more extended and irregular. On reaching the summit, a large circular cavity, some fifty yards in diameter is seen, in which are two distinct pools of unequal size, divided by a mound of earth, one containing the liquid mud, the other clear water. The surface of the former was slightly agitated by about a dozen small jets which bubbled up at intervals, but in the latter, only one was occasionally visible. A space of a few yards ex-

tended on three sides from the outer crust to the edge of the cavity, which was about 50 feet above the level of the pools: their sides are scarped and uneven. On descending the northern face, I remarked a small stream of clear water flowing from one of the fissures into the plain, which had evidently only been running a few hours: the mud water of all the pools is salt. A fourth pool situated close to the great range of Haras, and distant from the rest upward of six miles, was pointed out as having a similar cavity to this one. Its colour is the same, and although the surface is more rounded, its summit appears broken. I regretted not having an opportunity of visiting it. The name given to these singular productions of nature is the "Koops, or Basin of Raj Ram Chunder." They are said to be altogether eighteen in number, seven in this neighbourhood, and eleven between Kedje and Gimmadel in Muckran. Four were pointed out to me, and I was told the other three were hid among the mountains. Some persons with my party had seen one of those in Muckran, and had heard from the Beerooes who shewed them the road, that many others were spread over the country: he described it as throwing up jets similar to the large hill here. By the Hindoos, they are looked upon as the habitation of a deity; but the Mahommedans state, that they are affected by the tide, (the sea is not more than a mile distant from the large one,) but this I had reason to doubt, as of the many persons I questioned who had visited them at all times, not one remembered to have seen the pools quiescent, although several had been on the large hill when the mud was trickling over the side of the basin. To endeavour to ascertain this fact, I placed several dry clods of earth in the bed of the channel on a Saturday, as I expected to return by the same route on the following week. A range of low hills of irregular form lie to the westward of, and almost close to, the Chunder Koops. I had not time to examine them, but from their appearance, I judged they contained sulphur, and on questioning some of those with me who crossed them, they said the taste of the earth was like that near the hot springs of Sehwan where it is known to abound. A Hoomrea who was present, mentioned, that about six coss off, there was another hill called by the name of the "Sulphur Mountain."

Describing the valley of the Aghor or Hingool river, Captain Hart remarks: "The faces of the rocks towards the stream are broken and craggy. That on the left bank is higher, and more scarped than its opposite neighbour. Beyond them in the distance is seen a range of light coloured sand-hills, to all appearance nothing but a mass of conical-shaped peaks, and towering far above them, are the blue mountains of Hinglaj, precipitous and wild." "On ascending the left bank of the river, after passing between the peaks of the mountains, which seem as if they had been severed by some convulsion of nature, a full view is obtained of the sand-hills. They appear to consist of one irregular range, cut in two by the river, extending southward to near the sea, and northwards far into the mountains. They are from three to four hundred feet in height, covered from base to summit with num-

berless small conical-shaped, ribbed peaks, like that of the Chunder Koops, and their surface appears to have been baked to hardness by the sun." In this range of hills it is highly probable, that numerous mud volcanoes, similar to those already described by Captain Hart, would be found, and the entire tract is evidently the seat of active volcanic forces. The result of Captain Hart's experiment on the activity of the Chunder Koops is thus described: "On our way back, nine days after first seeing them, I again visited the Chunder Koops. The appearance of the one that was fallen in, was as sand in a muddy pool, and the water instead of being clear as before, was quite discoloured: the stream also had ceased flowing for some time, as the plains bore no marks of moisture. On reaching the summit of the larger one, it was very evident that an eruption had taken place the day before (Monday,) for the channel on the western side was quite filled with slime, which had oozed down the side of the hill, and ran some thirty yards into the plain below. The dry clods I had placed when before here were covered, and it was not safe to cross where the mud had found an issue, whereas my whole party had when with me, walked round the edge of the basin. The jets rose as usual. So tenacious is the mud of this one, that even cocoa-nuts which the Hindoos throw on it do not sink, but in the others it is more liquid. No alteration had taken place in the appearance of the small Koop."

From these interesting details, and from the fact that throughout the tract of country on both sides of the Indus near the sea, hot springs are disseminated; it appears that the usual characteristics of localities subject to Earthquake shocks are found in that now under notice. It is to be regretted that our information relative to the actual occurrence of Earthquakes here is so very limited; but the inhabitants of the country are unsuited for retaining and transmitting such observations, since even the great shock of 1819 was, as Captain Burnes informs us, early forgotten, and had intelligent European observers not been on the spot shortly afterwards, the event would probably never have been heard of, and the many interesting phenomena their labours have served to eliminate, would have been lost to science.

Captain Burnes informs us, that it is the general belief among the inhabitants of the province, that "the sea is receding from the southern shores of Cutch," or more correctly, as the sea-level continues unaltered, that there is now taking place a very slow and insensible elevation of the coast of Cutch, similar most probably in its nature to that in progress on the coasts of Sweden, the reality of which has been satisfactorily established by Mr. Lyell. This elevation would seem to be much more extensive than Captain Burnes was aware of, since, if native traditions are to be depended upon, a like process has taken place in the province of Lus,* on the same coast of the Arabian Gulf, but much farther to the westward: in the same tract of country indeed in which the mud volcanoes formerly described are said to

* Lieutenant Carless, I. N. Memoir on Lus, As. Soc. Jour. Vol. VIII, p. 154.

occur. No definitive information on this very interesting point has yet, however, been obtained, but the establishment of proper marks to which future reference could be made, would be an object worthy of the attention of the Officers just deputed to the survey of Sinde; for on the coast of Sinde as well as on that of Cutch and Lus, if the movement be a real one, indications of its existence would in time be furnished.

During the year 1842, an Earthquake was experienced at Baroda, but no account of its course was, so far as I am aware, made public. I have already expressed my regret at this, as the shock may possibly have emanated from the tract under notice, but as this cannot now be ascertained, it is unnecessary to allude farther to it.

6.—*Earthquakes of the Tract of the Vindhyan Mountains.*

The Vindhyan mountains extend in an almost unbroken chain from the Gulf of Cambay to the valley of the Ganges, thus traversing the entire peninsula of India at its base, and forming the connecting line of the mountain ranges of northern and southern Hindoostan. It is probable indeed, that at one period the Vindhyas crossed the Gangetic valley, and being connected with what are now called the Garrow Mountains, abutted ultimately on the Himalayas. Throughout the whole of this extensive range, indications of volcanic action are developed in a most remarkable manner. This action, speaking comparatively with what it has been at a former epoch, may now be described as almost extinct; but there are still occasional proofs furnished of the forces once developed on so large a scale being yet in existence, although with much reduced intensity. The development of trap rocks in the central portion of the Vindhyas is the most remarkable feature in their physical structure; the details of this have so frequently been given already, that it is unnecessary for me to do more than merely to allude to them here. Hot springs are also most abundant, and have been described by various observers, as extending from the valley of the Nerbudda to that of the Ganges. That Earthquakes should occasionally be experienced within a region so abundant in marks of igneous action was to be anticipated, and it is only remarkable, that the number recorded should be so few, and their intensity so feeble.

The earliest historical notice we have of a convulsion of this class is that relating to the destruction of the city of Oojein, (lat. 23° 11′ N., long. 75° 35′ E.) by a shower of volcanic ashes, in the time of Rajah Vikramaditya, 56 B. C. Sixty other towns are said to have been involved in the same catastrophe, but it must be admitted that the tradition on which this statement is based is apocryphal, being unsupported by any physical evidence of volcanic action within the historical period in the vicinity of the place, so far as its examination has been carried. It seems, however, scarcely possible, that a volcano capable of ejecting a shower of ashes on so enormous a scale could have wholly escaped research, and in the present state of our information, the destruction of Oojein from igneous action must be held doubtful. Captain

Dangerfield states, that in the neighbouring Vindhyas, and in the wild tract of Rajpeeply, (Malcolm's Central India, Vol. II, p. 325), some hills are said to have hollows in their summits resembling extinct craters, but as he had never seen them, he could not hazard an opinion as to their true nature. In Malwa, where igneous rocks are almost universal, Earthquakes are said to be frequent, but no special instances are mentioned.

It is not until the year 1842, that the dates of any Earthquakes emanating from the Vindhyas have been ascertained. The Earthquakes of the 21st and 23rd of May 1842, by which many places in the vicinity of the Rajmahal hills, the eastern termination of the Vindhyas, were smartly affected, are decidedly referable to the tract now under notice. The direction of the shocks as noted in my Register, and their comparative intensity at different points varying in their distance from the hills establish the point. Since the publication of the Register for 1842, I have received a few farther details connected with the above mentioned Earthquakes which I may give here. For these I am indebted to the ever-active kindness of Mr. Piddington, Sub-Secretary, Asiatic Society, who forwarded to me the proof sheets of his Seventh Memoir on Storms, in which the details in question were given. This is only one of the many similar acts of kind assistance I have received from this gentleman, and my best acknowledgments are due to him.

Gya.—Lat. 24° 49′ N., long. 85° E. Relative to the Earthquake of the 21st May, W. St. Quintin, Esq. C. S. writes as follows:—

21st May.—"At 20 minutes before 9 o'clock A. M. we had two smart shocks of Earthquake from West to East; for some days before and after this, the sky had a white, thick, hazy appearance. The heat of the weather was most oppressive. Thermometer never under 90° and often at 95° in the house, and 115° in the shade of the outside verandah."

Monghyr.—Lat. 25° 23′ N., long. 86° 38′ E. Mr. Palmer of Monghyr writes thus: "The whole of this season, I mean from January (1842,) has been rather a remarkable one, and very different from what I have observed at this station for the last seven years. The annual passing showers of January and February did not visit us. March and April, though generally one stream of strong N. W. and N. E. winds, approached us with somewhat less fury, and with a succession of a day or two intervening between the gusts. May was sultry in the day without the usual hot winds, but attended with a cooler feeling by midnight, until near the 19th, when the air became heavy and oppressive to a degree, and the sky had a peculiar hue about the time of sun setting. This continued until the morning of the 21st, and though we looked forward to some kind of coolness, or a light air about dawn, it was the reverse this morning: a lethargic sensation seemed to hang about until a quarter after nine, when the earth was observed to tremble and rock from East to West (from West to East?) for half a minute, vibrating

those wall shades only in that line, when as if a second shock, though I could perceive no stop, came from the direction of N. and S. affecting the wall shades again in that line: the last undulation appeared to be the strongest: this was repeated three times, each with less force. On the 23rd, two more slight shocks were felt, since which period up to the night of the 2nd of June, the sky assumed every evening an ashy colour, blended with tints of a salmony hue and very oppressively hot. A strange effect it appeared to have on all trees in either blossom or young fruit. As proof of this, the whole of the fruit in my garden was stunted in its size with a kind of harsh flavour, though free from any worm: the blossoms falling off as if each leaf was partially baked to make it crisp."

About five miles from Monghyr is the Seetacond, a hot spring celebrated as a favourite resort of Hindoos. Its temperature is variable, sometimes rising as high as 136°, and sometimes being only 92° or 93°. It is a remarkable fact, that Monghyr seems to suffer more from Earthquake shocks, from whatever direction these may come, than any other place in its vicinity. This was observed during the shock from the lateral Himalayan tract, of the 26th August 1833, again during that of the 11th November 1842, and I would say from the information before me, that on the present occasion, the shocks were smarter at Monghyr than at any other spot. What the cause of this greater susceptibility may be, it is impossible at present to say, as it would be necessary to know the locality thoroughly, before any could be with propriety or confidence assigned, but the *fact* seems well established.

It would appear from the following remarks of Dr. Hamilton Buchanan, in a paper on the minerals of the Rajmahal hills, that towards the western extremity of this range, there are decided indications of igneous action.

"I have said," Dr. Buchanan remarks, "that Rangreswaritok at the western extremity of the range appears to me to have been the crater of a volcano. It is a conical hill about 300 feet in perpendicular height, and very steep on all sides. On reaching the summit, you find it consists of a great cavity surrounded by a thin ledge, and descending to very near the level of the plain. The ledge now is of unequal height, having in some places given way, especially towards the East, whence a gap about 30 yards wide at the bottom gives access from the outer plain with very little ascent, and allows the water from the cavity to escape. Towards the summit, the inner ledge consists of abrupt rocks, but the bottom is filled with the debris of the portions of the ledge that have fallen. Much slaggy matter is to be found on the outside of the hill and at the bottom of the cavity." "I was informed by Isfundyer Khan, a fine young man, assistant to the Sezawal who manages the hill tribes, that about five years ago he heard of a smoke that issued from a hill named Chapar Bhita, about seven coss S. E. from Karariya. He visited the place, which was not hollow, and

consisted as usual of earth mixed with a great many fragments of stone. In the day it was not luminous: but that a thin smoke issued continually from a space 8 or 10 cubits in diameter. He heard that at night it was luminous, but he did not see it in that state. On throwing wood on the hot place in a few minutes it took fire. These appearances continued for about three years and then stopped." Dr. Buchanan farther mentions that the whole tract of the Rajmahal Hills abounds with hot springs. (*Gleanings in Science*, Vol. III, p. 6.)

It is anticipating materials not yet properly arranged, but I may mention that other Earthquakes have occurred during the year 1843 referrible to the Vindhyan tract. These will be duly noticed in the Register for the present year, and it is only necessary to mention here, that one of them shews the continued action of the disturbing forces throughout those igneous districts of Central India, where once its intensity was displayed on so extensive a scale.

7. *Earthquakes of the Tracts of the Delta of the Ganges.*

The forces which have given origin to those Earthquakes which have from an early period been known to affect Calcutta and its vicinity, are probably to a certain extent connected with those of the tract next to be described, namely, that of the Arracan coast; but it is proved by several examples that the Earthquakes of the Delta may occur with entire independence of those on the coast, and I have therefore felt warranted in making the former a distinct focal locality.

The earliest notice of an Earthquake referrible to the Delta of the Ganges, that I have been able to find, is contained in the following extract from "The Gentleman's Magazine," printed in 1738-39. I am indebted to Major H. B. Henderson's Chronological Tables for the notice, which runs thus: "In the night between the 11th and 12th October 1737, there happened a furious hurricane at the mouth of the Ganges, which reached 60 leagues up the river. There was at the same time a violent Earthquake which threw down a great many houses along the river side: in Galgotta (*i. e.* Calcutta,) alone, a port belonging to the English, two hundred houses were thrown down, and the high and magnificent steeple of the English Church, sunk into the ground without breaking. It is computed that 20,000 ships, barks, sloops, boats, canoes, &c. have been cast away. Of nine English ships then in the Ganges, eight were lost, and most of the crews drowned. Barks of 60 tons were blown two leagues up into land over the tops of high trees: of four Dutch ships in the river, three were lost with their men and cargoes; 300,000 souls are said to have perished. The water rose forty feet higher than usual in the Ganges."—N. B. The steeple of the Church was described to have been lofty and magnificent, and as constituting before this period the chief ornament of the settlement."

No Earthquake of equal violence with this has ever since occurred, and it is the only one in which fissures in the earth to any extent have been observed. It is farther remarkable as having been accompanied by a terrific hurricane, a coincidence however by no means rare, and

to which attention will be more particularly directed at a subsequent time.

The next shock of which I have obtained intelligence, occurred at Calcutta in the month of April 1810. It is described in the following Extract from the Asiatic Annual Register, Vol. XII., kindly forwarded to me by Mr. Piddington.* "April 3d, on Sunday evening last, presently after the cessation of a smart north-wester, two successive shocks of an Earthquake were distinctly felt in many parts of Calcutta and its vicinity. The time of its occurrence, as noted by different persons, was between 20 and 25 minutes past 7 P. M., and the duration of each successive shock was variously estimated at from 6 to 30 seconds. The vibrations appeared at first to pass in a line from north-east to south-west, and then to return in an opposite direction. They were almost universally perceptible to those who were sitting at the time in the upper apartments of their houses, but were in a few instances, observed on the ground floors. At one house in Garden Reach, where a party of eleven were sitting at dinner, the shocks were very strongly felt by three of the number seated at one corner of the table, and also by the three others at the opposite corner, while they passed unobserved by the rest of the company. Besides the peculiar sensation experienced in their own persons by those who witnessed the pheno-

* With the above account of the Calcutta Earthquake of 1810, Mr. Piddington forwarded to me another of a shock experienced at *Matura* on the night between the 31st August and 1st September, 1803. I have found it impossible to identify to my own satisfaction the geographical position of the place called *Matura*. In the month of September 1803, the British Troops took possession of *Mathura*, a town in the province of Agra, (lat. 27° 32′ N., long. 77° 37′ E.) and this may possibly be the place alluded to, in which case the Earthquake would be referrible to the Aravulli tract. From my uncertainty as to the position of Matura, I have given the account of the Earthquake in a note, instead of in the body of the memoir. From the style, the notice would appear to be a translation from a native account.

Extract from Asiatic Annual Register for 1804, *Vol. VI.*

Bengal Occurrences for October, 1803.

Matura, September 24th, 1803.

"On the night between the 31st August and the 1st of September, at half an hour after midnight, a severe shock of an Earthquake was felt at this place, which lasted for many minutes, and was violent beyond the memory of man. Probably not a living creature in the place but was roused from his slumbers by the alarm, and felt its effects. Many of the pucka (Masonry) buildings were cast down, and zenanahs hitherto unassailed by violence were deserted, and their fair inhabitants took refuge in the streets and in the fields in dishabilles which had no effect to conceal them, and in affright which elevated their charms, seeking protection with men whose visages it would otherwise have disgraced them to behold.

"In the morning very extensive fissures were observed in the fields, which had been caused by the percussion of the night before, through which water rose with great violence and continues to run to the present date, though the violence has gradually abated. This has been a great benefit to the neighbouring ryots, as they were thence enabled to draw the water over their parched fields.

"The principal mosque of the place erected on an eminence by the famous Ghauzi Khan as a token of his triumph over the infidelity of the Hindoos, has been shattered to pieces, and a considerable part of the dome was swallowed up during the opening of the earth.

"Several slighter shocks have since occurred, but I do not hear they have occasioned any farther damage."

menon, in many houses a very distinct motion was communicated to the oil in the wall-shades; the girandoles and lamps were seen to swing, and even the mirrors (such as were fastened at the upper extremity with a cord) were observed to vibrate towards the wall. In a room on the central floor of one of the turrets of the lower Orphan School at Howrah, (which is a very old and infirm building,) the force of the undulations was so considerable, that a couch on which a person happened to be reclining was moved on its castors at the first shock to the distance of nearly a foot from its original position close to the wall, and was again thrown back to its place by the returning succession. To some persons the vibration appeared to be accompanied by a noise which they describe as resembling the sound of muffled bells.

"Reports from various stations in the lower parts of Bengal, as far up as Moorshedabad, mention the occurrence of a similar phenomenon, nearly about the same hour. By a letter from Ramnagur, the vibration is stated to have been felt there at half-past seven, and to have continued for an unusually long time."

No farther notice of Earthquakes in the Delta of the Ganges occurs until the year 1829, when on the 18th September, at a little past 7 A. M., two shocks which are described as having been "very strong," were experienced at Calcutta. I have found only a very brief notice of these shocks, and beyond the fact, that the movement of the earth during their continuance was vertical, or "up and down," I find nothing else of interest recorded.

Another long interval of quiescence occurs, and it is not until the 11th November 1842, that we have any other Earthquakes at Calcutta, or in its vicinity. On that day at nearly half-past 9 P. M., an Earthquake was experienced throughout the Delta of the Ganges, which from the published accounts would appear to have been the most severe felt within the previous twenty-five years. All particulars connected with this shock have been given in ample detail in the first part of this memoir, and I need not therefore dwell long upon it here. It was a shock evidently originating *within* the Gangetic Delta, not communicated from any other tract: it was felt very feebly indeed at the northern extremity of the Arracan region, and not at all, that I am aware of, at any of our stations along that coast: its intensity diminished perceptibly in its course from the vicinity of Calcutta, in all directions, and even had we no other grounds for establishing the Delta of the Ganges as an independent Earthquake tract, this shock alone would I think be sufficient to warrant our doing so. The point where the disturbing forces act is in the immediate vicinity of Calcutta, since it is there that the intensity of the recorded shocks has always been greatest. It is possible, however, that had we equally good intelligence from other localities in the Delta, it would appear that the vicinity of Calcutta was not the only centre of disturbance, and as observers and observations are multiplied, a wider range may perhaps be given to the forces in action.

The occurrence of Earthquakes is at present the only indication furnished of the existence of disturbing forces beneath the Delta, but if we may form a judgment from the results of the Boring operations in Fort William, such forces must at no distant period have acted with an intensity much greater than we have had any evidence of since we became acquainted with India. The section of the Delta furnished by these operations exhibits a series of strata alternately composed of coarse gravel and fine river sand, or lacustrine mud, accompanied by two remarkable deposits of carbonaceous matter, one near the lower, the other near the upper extremity of the section. The lowest stratum, attained at a depth of 392 feet from the present surface of the Delta, and continued to 480 feet, consists of coarse conglomerate composed of large rolled fragments of primary rocks. To this stratum, on grounds as plausible as the circumstances of the case will admit, Dr. McClelland has assigned an age of nearly 3,300 years. Since that epoch, therefore, all the subsequent changes of level in the Delta, so clearly intimated by the nature of its constituent, strata must have taken place, and as in the latest of these changes, a subsidence of the surface of the land to an extent of 75 feet in depth is indicated, it may reasonably be inferred, that a high intensity must have characterised the disturbing forces to which a change of such amount was due. Those who may wish to examine the points just alluded to in greater detail, are referred to my Memoir on the Structure of the Delta of the Ganges in No. 3 of Dr. McClelland's Journal, where all necessary information will be found.

8.—*Earthquakes of the Eastern Coast of the Bay of Bengal.*

In tracing the geographical limits of the various volcanic regions throughout the world, Mr. Lyell makes the great train of the Molaccus to terminate abruptly with Barren Island in the Bay of Bengal, (lat. 12° N.)* But the entire eastern coast of the Bay of Bengal, as far to the northward as Chittagong is essentially and prominently volcanic, and along the Arracan coast especially are the indications of igneous forces most distinct. To these I will subsequently refer more in detail, but at present I must proceed to notice the Earthquakes which have been experienced throughout this tract.

Our acquaintance with the Arracan tract is comparatively speaking, so recent, that the evidence of the frequent occurrence of Earthquakes throughout it, is chiefly traditional and physical, and it is not until the middle of the eighteenth century that we have the actual date of any such convulsion, strictly ascertained. On the 2nd of April 1762, however, a great shock occurred, affecting the whole of the eastern coast of the Bay of Bengal, and extending to some distance into the interior. The most ample details of the nature and effects of this shock were observed in the vicinity of Chittagong, and are recorded in

* In the map the sixth Edition of Mr. Lyell's work, which Lieut. Smith has evidently not seen, the volcanic band is very properly carried on to Chittagong.—Eds.

Vol. LII. of the Philosophical Transactions, from which the succeeding extracts have been taken.

"XXXIX.—An account of an Earthquake at Chittagong: translated from the Persian by Mr. Edward Gulston, and communicated by him to the Rev. Mr. Hirst. Read, 17th November, 1763.

Reverend Sir,—The following was written by a Persian writer, pursuant to an order from Harry Verelst, Esq., Chief of the Honorable East India Company's province of Chattigaon, in the kingdom of Bengal, and sent to Calcutta, for the information of Messrs. Vansittart, Hastings and others, acquainted with that language. As it is of indisputable authority, I have taken the pains to copy and translate it for your satisfaction, being, &c. &c.

Calcutta, November 1, 1762." EDWARD GULSTON.

Account of an Earthquake which happened in the region of Islamabad on the 22d of the month *Chyte*, 1168, Bengal æra, (answering to the 2d of April 1762,) on Friday about 5 o'clock in the afternoon, which according to the best advices I have written and now send you.

Particulars are as follow:—

"The land of Mahommed Assad, Chowdry of the Pergunnah Deeâng, at a place called Barreeah, is laid open by the shock from 10 to 12 cubits in width, and become as it were, a deep creek: the water rising up so, that the ground of the farmers inhabiting the place is 8 cubits overflowed.

"And at Deep in the Chowdraj of Mahommed Athyâr, the like hath come to pass.

"And Moktârâm Fowtahdar, dwelling at Goyparah, has written that to the North and East, his house was cracked, and water there spouted up like a fountain, and the ground also sinks every day by little and little.

"And by letter from Satos Mester, Darogah of the Salt-works at Bansbareeah, it so fell out that to the westward, Akl'poorah, an island of the salt-works was levelled with the water on its East side, and on the North and South the ground opened from 5 to 7 cubits in width, and sunk like a pit to the depth of 10 cubits, the water spouting up; nor is there the least appearance of its subsiding: we know not what will come of it.

And from the reports of the people there we hear, that these places were never before overflowed by the water, we cannot at present tell what misfortune has happened. However, all the Government's salt was before this laid up in store-houses. Moreover a mud building of your servants' (the writer of this account,) was almost destroyed by the shock; but it still stands upright.

And at Haldah, about 12 doon of land belonging to Sacheeram Cannoongoey, is entirely sunk into the water.

In like manner in Takaleah, about 5 doon of ground, the property of Barjallâál Chowdry, has fallen something below its primitive level.

And at ditto Hâzâry, Harry Singh's house and a brick building of Shere Zaman Khan's came down, and the Khan was hurt by the fall of his: and there opened a cavity like a ditch of 200 cubits in length, which filled with water.

At Howlâ, the house of Shiam Ram, tax-gatherer, broke down, and his whole enclosure was torn up, and in most places his house and fish-ponds were filled with sand banks: even now the whole spot is two cubits under water.

And, at Dahrampoor, the house of Santeeram, the Cannoongoey's writer, entirely fell down.

The Katwâll of Islamabad (Chittagong,) informed us with his own mouth, that in a place called Baramcharah, the water was up to a man's waist, and the people there have betaken themselves to flight through fear of perishing: no living creature but the cattle remaining.

And in the house of Santeeram Cannoongoey of Islamabad, a bricked room was ruined, and one of his brethren, named Rajah Ram, was killed by the fall of the bricks.

And the house of Nandaram coming down in the same manner, a son of his was knocked on the head.

And to the westward of Kadr Katcheah, a large hill, called Kaddaleah, very near Karn Phooly, was rent, and it stopped up the passage for boats in and out of that river. And at Bajabeah, Sangetty and ditto Hazary, creeks were closed up by banks of sand rising from their bottom. And at Gandarah Jowar, about three doon of land belonging to Mahommed Alli Chowdry, rent, and was swallowed up, and the passage in and out his house also cleaving asunder, the water rose up, and has flowed all round the house.

Moreover, the factory house, a strong building in the fort of Islamabad cracked from top to bottom and tumbled down, and an apartment newly built was also rent.

And to the eastward, a large pond of Belah Khan, became a deep gulf: and to the east also of Aghy Gunge, belonging to the city of Islamabad, the ground in different places clave asunder, water rising up as from so many springs.

And at Chehpayttlee, about 12 katy of land, belonging to Sâjúr Chowdry, was overflowed, and rendered unfit for tillage.

And from letter of Chehtarnarayn, surveyor of the lands, we learn, that the north side of the Chacklah Sowabeel, just by Haldah river, broke down, and is swallowed up by the river, and also four people were overwhelmed in its ruins.

And Mr. Griffith's brick house (in Islamabad) has been cracked, also the house and walls of Juan de Baris, a Portuguese here.

And from Nahal Charah there is news, that greater part of the ground of that island clave asunder, and is swallowed up by the waters, and hundreds of people perished with it. Besides this, the state of that island will be known to you from a Bengal account.

From the Jooms, whose country is about four days off from Islama-

bad, we learn that Reang hill split in two, and sunk 40 cubits: also that Kachalang hill is even with the ground.

And Bahugoo Changu, a Joom hill, rent in twain, and is sunk 30 cubits, and the houses of most of the inhabitants in these parts thrown down.

And a Joom hill, Chahter Patterah, split by little and little, till it is almost level with the plain: and because of the opening of the hills and the destruction of the trees on them, the way by which the Jooms used to pass is stopped up.

And Bajaleeah, another Joom hill, opened 30 cubits, and sinking, water rose up: and Palanga Joom hill split and sunk 25 cubits.

The design of this is to lay before you the wonderful disorders that have come to pass in these regions, and which continue to happen, in so much, that since the time of Adam until now, in this place no one has heard of the like.

If I should describe them with a thousand instances and relations, and make mention of so many particulars, still there would not be a part in ten that I could bring within the compass of writing. But these few particulars I send for your Excellency's information."

Farther details of this great catastrophe are contained in the following communication from the Rev. Mr. Hirst, to the Rev. Thomas Birch, Secretary to the Royal Society, read November 17, 1763.

Calcutta, November 3, 1762.

Reverend Sir,—To the enclosed accounts of the transit of Venus, I have subjoined others of an extraordinary Earthquake felt in this part of the world, which I flatter myself will not be unacceptable to the Royal Society.

The Earthquake happened the second day of April last, was very violent in the kingdom of Bengal, Arracan and Pegu; but especially at the metropolis of Arracan, where, according to the accounts of an English merchant residing there, the effects have been as fatal as at Lisbon, and where it is thought the chief force of the Earthquake vented itself. At Dacca, in this kingdom of Bengal, the consequences have been terrible; the rise of the waters in the river was very sudden, and so violent, that some hundreds of large country boats were driven ashore or lost, and great numbers of lives lost in them.

No less deplorable are the accounts from Chattigaon in this same kingdom; three of these accounts I herewith enclose, one of them wrote by Mr. Edward Gulston, a young gentleman in the service of the East India Company, and two others translated from a Persian original, made out by order of Mr. Verlst, chief of our East India Company's affairs in that province; in consequence of which accounts, the Company's lands there have not been so highly assessed as before this calamity. Both these accounts are translated from the same original; but that which I received from Governor Vansittart, being thought exaggerated from interested motives, I begged Mr. Gulston to give me a literal translation from the Persian, in which language he has made

an uncommon progress, as much to his present honour, as I hope it will be to his future advantage. This favour he obligingly granted me, and I send it to you, Sir, not only to compare it with the other translation, but to give you some distant idea of the idiom and great simplicity of this Eastern language.

"The same Earthquake was also very alarming at Ghiratty, when Colonel Coote, with his Majesty's troops, was in cantonments, about 18 miles up the river from this place. The water in the river and tanks there were violently agitated, and in many places rose to more than six feet perpendicular height, of which I had occular demonstration myself on my return from Chandernagore, a settlement lately belonging to the French, about three miles North from Ghiratty, and in latitude 22° 54′ N. where it was felt, but not in a great degree: for I knew nothing of it myself, till it was soon after told me by a certain French gentleman there.

"Nearly, at the same time, was this Earthquake felt at Calcutta, as I am informed the agitation of the waters in the tanks rose upwards of six feet, and was to the direction North and South. The height of the thermometer on Fahrenheit's scale was then at Calcutta 95° 30′, much higher than it had been observed to be during the whole month, the lowest descent of the mercury being 89 degrees. In this month, there was much thunder and lightning, and there were fresh gales of wind at S. E.; the weather in general being close and sultry.

"A subsequent Earthquake was felt at Calcutta on the 13th of July following, at half-past two in the afternoon. The thermometer was then at 87° 4′ at a medium, the wind S. W., and the weather fair: to this I was a witness myself, being then at dinner with Capt. Eiser of H. M.'s 84th Regiment. The motion of the earth caused a very sensible vibration of the wine in our glasses, and the shock was repeated twice at the interval of a few seconds."

The great shock of the 2nd was followed by a succession of minor shocks, which continued until the 19th April, and are detailed in the following Extract of a letter from Mr. Edward Gulston at Chittagong, to Major John Carnac at Calcutta.

"Dear Sir,—The reason principally of this address is to give you a particular account of the shocks of a violent Earthquake which were felt here on the 2nd instant, at 5 in the afternoon, lasting the space of four minutes. The factory, a brick building, is quite spoiled, so as not to be safely habitable: for thereabouts, and in many other places, the earth opened, and the waters rushed out prodigiously: and in the chaise-road, especially towards the north quarter, there are great chasms, two feet wide and upwards, so strange, that the morning after riding that way, my horse started and went round another way, not willing to go over them.

"At the time of the first shock, great explosions were heard, like the noise of cannons, of which Mr. Plaisted and others counted 15.

"All the tanks overflowed their banks, fish were cast up, and the river rushed upon the shore like the surf of the sea. It was the most extra-

ordinary event I was ever witness to. By the enclosed paper you will discern how many alarms we had; however, nothing equal to the first, in which the whole force of the Earthquake seems to have been exerted. At present, the afternoon of the 4th April, all our heads seem to be quiet and still, and consequently the earth at rest; but really yesterday, from the repeated tremors of the ground, every one appeared giddy and alarmed, fancying the earth to be in perpetual vibration, which, however, an experiment of placing a glass of water on the floor proved to be not the case. I would not that such a shock as the first should happen at Calcutta for all I am worth, since of necessity the terraced houses must fall to ruin, and I please myself with the thoughts, that we have had the worst of it.—*Chittagong, 4th April*, 1762.

"Copy of the paper mentioned in the foregoing letter:—

Chittagong, April 2, 1762.

"April	2,	at 5h.	P. M.	A severe shock of an Earthquake, lasted four minutes.
		5h.	12m.	A second, lasted one minute.
		5	30	A third.
		7	0	A fourth.
		10	0	A fifth.
,,	3,	1	A. M.	A sixth.
		2	,,	A seventh.
		3	,,	An eighth.
		5	,,	A ninth.
		10	25	A tenth.
		10	30	A eleventh.

"Between 6 and 7 in the evening, I felt a twelfth shock: also others upon Marriott's hill, at a distance from Mount Pleasant, which every one thought in continual motion."

The following translation of another Persian paper, concludes the series illustrative of the effects of the shock now under notice.

"The weather being very close and warm for some days preceding, on the 2nd April, about 5 in the afternoon, we were alarmed by an Earthquake; which beginning with a gentle motion, increased to so violent a degree for about two minutes, that the trees, hills, and houses shook so severely, that it was with difficulty many could keep their feet; and some of the black people were thrown on the ground, whose fears operated so powerfully, that they died on the spot: others again were so greatly affected, that they have not recovered themselves since.

"On the plains, by the river and near the sea, it was chiefly felt with great severity.

"Our bungalows proved very convenient on so melancholy an occasion, for had we been in brick houses, they must inevitably have been shattered or levelled with the ground; as there is not a brick wall or house but is either greatly damaged or fallen.

"Our new room in the fort, although as strong as bricks and chunam could make it, is shivered from all sides from top to bottom; and the old building, equally cracked, is in great part tumbled down.

"The motions were so complicated, that we could not well determine their direction: being sometimes from West to East, and again from East to West: and the tanks in some places overflowed from North to South.*

"In Pergunnah Deeang, Bursea Gong, the ground in several places opened ten and twelve cubits wide: and in some parts so deep, that they could not fathom its bottom, the water immediately overflowing the whole town, which is sunk about seven cubits.

"Deep Gong, a village near the other is also sunk, and now lies seven cubits under water.

"From Patter Gattah to Howlah, a distance of 8 coss (12 miles,) the ground opened, and a great quantity of water was immediately thrown out, and in several places the ground entirely sunk.

"At Bansburreah, Akulpoor, near the sea, the earth opened in seven places, like wells, throwing up the water ten cubits high: the great cutchery there with brick walls, is cracked and shivered to pieces.

"At Huldah Creek, near Sancheram Conguy's house, twelve don of ground is entirely sunk.

"In the Pergunnah ditto Hazary, Hurry Sing Hazary's brick house was entirely thrown down: the hall of Seer Jumma Khan's brick house also fell, and himself was greatly hurt by the bricks: near which the ground opened 200 cubits, and immediately filled with water, which is now unfathomable.

"In Howla Pergunnah, Sam Roy Gapildar's house broke down, and his compound was filled with water of two cubits deep for two days.

"In Berrum Cherra, the ground overflowed about two cubits deep.

"Near Kutcha Ghaut, Kurrolea hill opened, and a great part of it fell into the river.

"Bagally Creek and ditto Hazarry Creek are both filled up.

"At Gunderah Juwar, three don of ground is entirely sunk.

"Ali Chowdry's compound opened, and the water that immediately flowed out, filled a deep ditch that surrounded his house.

"From Suwabill Purgunnah to Mooradabad, three Taluckdar's grounds are entirely sunk, and four people killed.

"At Bar Chara, near the sea, five or six coss of ground immediately sunk, and out of four or five hundred people, about two hundred were lost, with all their cattle: and the greatest part of the remaining inhabitants, who ran into the woods, have not since been heard of.

"Nulla Nunderam's brick house was broken down, and his son who was in it then, was so much bruised, that he died in three days afterwards.

* The ground opened in several places in the town, throwing up water of a very sulphurous smell: and several tanks and ditches were filled up, which are now level dry land.

" At Lalettee, Selcope Chukla, the ground in some places opened and threw up great quantities of salt water, and in others entirely sunk ; the channel of several creeks and little vallies between the hills were filled up with great quantities of sand ; in some places, the water still continues twenty cubits deep, and in others unfathomable.

" Silluk creek and Islammuttee river are both stopped up ; several boats laden with goods then coming down, are not now able to get out of them : the country around there opened greatly in some places, and in others, entirely sunk : and a great many tanks filled with sand.

" Bur Coller hill opened about forty cubits wide.

" Sess Lung, Joom hill, one of the Mug mountains, is entirely sunk.

" Chungee hill opened between twenty and thirty cubits.

" Padoorah Creek, at that time without water, opened and threw up two hills of sand : and all the houses in these parts were broke down.

" Joom Chatea Pedea hill is sunk so low, that its top is now on a level with the plains.

" Rigerry hill, which was very large, opened thirty cubits wide.

" Joom Palang hill opened twenty-five cubits.

" By the accounts already come in, there are 120 dons* of ground lost in the different parts of the province ; but these I am afraid will not be one-eighth part of the whole damages, as we have farther relations coming in every hour.

" As we are informed that two volcanoes opened, I am in great hopes these will prove a sufficient vent to discharge all the remaining sulphurous matter in the bowels of these countries, and put a stop to any farther Earthquakes here, at least for many years to come."

The hope, with which this paper closes, would seem to have been realised, as no farther shocks of severity from 1762 to the present time, are recorded, as having occurred in the province of Chittagong.

We have but very limited accounts of the effects of the Earthquake of 1762 upon the Arracan coast in general ; but its influence on the Island of Chedooba, as described by Captain Halsted, (J. A. S. Vol. X. p. 433, &c.) may be taken as a specimen of what occurred, in all probability throughout the entire archipelago of volcanic islands which skirts that interesting coast. The whole of Captain Halsted's remarks are so intimately connected with my subject, that finding a difficulty in making a selection, I have thought it preferable to quote them in full.

" The geology of Chedooba," Captain Halsted remarks, " presents characters of so much general interest, that any report on this island might be looked on as imperfect in which the subject was wholly omitted.

" But as it is intended in a separate notice to give such details as may render the subject capable of investigation by those able and interested in the science, the present one will be confined to a mere statement of the general features exhibited.

* One sye don of ground is 1,920 cubits long, and 1,600 cubits broad.

"The elevation out of the sea of large tracts of land by effect of volcanic action, has in more modern times been noted as occurring on the coast of Chili in South America, and in the territory of Cutch in this country. In the former case, some doubt has been thrown both on the fact itself, as well as its amount: and the circumstance of a similar phenomenon having taken place within the memory of man, not only throughout the coasts of Chedooba, but extending over all the shoals and islands from the Terribles, off the North end of Ramree, to Foul Island, will be held a not unwelcome addition to the evidence yet gleaned of the occurrence of such extensive changes of level to the present day. The above are the limits of the survey on which the "*Childers*" was employed, over every part of which the evidences of this elevation were seen, and in many places accurately measured, and it includes the whole of that irregular collection of islands and shoals, which, projecting far into the Bay of Bengal, yet maintains the general direction of the mainland coast near it.

"But these limits are not to be taken as those which bound the elevation, which with little doubt, from the similarity of formation, will be found to extend North, South, and East over all those parts of Arracan, so peculiarly marked by the intersection of deep, narrow, salt-water creeks from Akyab, even perhaps as far South as Cape Negrais.

"The line which was under observation was about 100 miles in length, varying from 20 miles in breadth to that of a mere patch, according as the opportunity for notice was afforded by the existence or islets above water, and its general direction is from NW. by N. to SE. by S. The elevation has been greatest towards the centre of the line examined. At the Terribles, about 13 feet; on various parts of the N. W. reef of Chedooba 22 feet; at the North point of the Island 16 feet; at the centre of the Island, on the West coast, 13 feet; at the South end 12; and at the Islands south of it, as far as Foul Island, from that to 9 feet.

"It would also seem to have been greater on the western limit of Chedooba than on the eastern; a fact however not ascertained from the extensive level plains which exist on this side, whereas on that, measurements were easily made on the sides of the perpendicular rocks. This elevation occurred about 90 years ago.* There is now living a party, 106 years of age, who was then 15 years old, and had been accustomed to fish over the now-upraised land. On the coasts of Chedooba, its traces are in most parts as clear as could be wished, bounding the natural jungle with a bank of greater or less height, composed of sand or of shingle: the plain beyond being thickly strewed with corals and shells, such as are now growing on the shores. The natives are all perfectly aware of the bank having formerly been the limit of their island, and even the youngest would point it out, if asked to do so.

* This is no doubt the great Earthquake of 1762, which, as before mentioned, extended all along this coast.

"The old man, above-mentioned, was not at Chedooba, but at Ava when the event happened: he had gone thither that year, and experienced at that place the violent Earthquake which accompanied the elevation. From other natives of great age I received the information not direct, but traditionally, from their parents.

"The Earthquake was very violent, the sea washed to and fro several times with great fury, and then retired from the ground, leaving an immense quantity of fish: the feasting on which is a favourite story throughout the island; no lives were lost, no rents in the earth occurred, nor fire from the volcanoes of the island.

"The above is not the only event of the sort traditionally known, as another occurred a century previous to it, and these elevations are considered periodical by the inhabitants, occurring every hundred years, and the next is even expected within the course of a few years, and would excite but little surprise.

"Traces of a third beach line were several times thought to be found before this information was given: but on the western coast, about half way down, an evidence of its truth was afforded by a remarkable column, or rock, about 40 feet high, standing on the beach, which shewed the remains of a second line of rock. Oysters adhering to it at an equal elevation of 13 feet above the first, as it was again above the one which on all the rocks of the western coast distinctly points out the limit of the present high water. On Flat Island were subsequently found these distinct beaches, and the corals found on the different extents of the island, clearly proclaimed, in their relative states of decomposition, the difference of their periods of exposure.

"The external and more apparent means by which these great changes are effected, are, so far as yet known, I believe quite peculiar, and exhibit features which may be valuable in assisting investigation into the immediate causes of volcanic violence.

"Every one of the mud volcanoes of Chedooba was visited and examined, as well as those of the neighbouring islands south of it, and on none, with strictest search could be found any traces of direct fire, or of those peculiar formations produced by that agent. Gas alone seems to be the one occasioning these strange exceptions to the general character of volcanoes. It is no doubt inflammable gas, and the light given by some of them has been so great, as to enable a book to be read by it at a distance of nine miles, as was credibly related to me as having occurred at the last eruption of the large volcano of Meubrung, the largest on the island. That heat is present in the more recent ones, I found myself to be the case, in one examined on Ramree, where the mud brought up on a bamboo from 17 feet in depth, shewed a temperature of 92° 20′ above that of the atmosphere. But a white stone-like chalk, found on all the large volcanoes, which was considered to be the common greenish sandstone discoloured by heat, was the only substance found which exhibited a trace of intense heat, and in this case the abstraction of colour above was effected without the least

change of composition or form. The large volcanoes of Chedooba are four in number: they are detached mounds rather than cones, varying from 100 to 1,000 feet above the level of the sea, composed of a stiff grey clay, with large quantities of singular fragments of stone; their sides much cut up by the effects of rain; their summits quite bare, and from 240 to 250 yards in diameter: on these are disposed cones of stiff clay from a few inches to four feet in height, and the same variety of dimensions in diameter. These are hard on the outside, but filled half way up with a thick, well mixed mud, which every now and then exudes from a hole at the side or summit, at the bursting of a bubble of gas which takes place every three or four minutes. There are two other volcanoes of small dimensions, and but little elevation above the plains where they are found to exist; they are composed of the same soil of mud emitting large bubbles of gas: and besides, there are two spots where water alone is brought up by the gas. In all these the water or mud is salt, and their number, with the four petroleum wells which are in constant ebullition with gaseous exhalations, seem to exhibit the agent as powerfully and extensively at work throughout the island. The minor volcanic vents seldom exhibit any change: the larger ones when in eruption, which generally takes place during the rains, either throw forth to a considerable height accompanied by flame, fluid mud which spreads over a certain extent on the surface affected boils with the escapement of gas, being too consistent to flow, or be thrown up. The angular fragments of stone mixed with the mud are clearly torn from the strata, through which the vent is forced, and small portions of copper ore (? more probably sulphuret of iron) are found attached to them.

"Besides the volcanoes seen, one was described as existing under water on what is now a reef N. W. of Flat Island, and which a few years since gave forth flame when in eruption. But independent of such direct evidence, a new examination of many of the reefs would convince us of the fact of the bed of the sea having been equally affected with the surface of the land.

"I was informed by a native, that the extensive new plain on the N. W. part of the island, which was raised out of the sea about 90 years ago, was only then acquiring its first covering of grass when he visited it 15 years after its elevation.

"The Island of Chedooba measures $15\frac{1}{2}$ miles in length; viz. from 18° 40′ to 18° 55′ 30″ N. latitude and 17 miles in width; viz. from 93° 30′ to 93° 47′ E. longitude, and shews on the map as a square, the South-west angle of which has been reduced with its dependency of Flat Island on the South coast; it covers an area of about 200 square miles. Its general appearance is that of a fertile, well-wooded island of moderate height and irregular outline. A band of level plain but little raised above the sea, extends around its coasts, of far greater width on the East than on the West. Within this lie irregular, low, undulating hills, varying in height from 50 to 500 feet, enclosing several higher

detached mounds of steep well-wooded sides, the loftiest of which, near the South part of the island, rises nearly 1,400 feet."

From the details given in this extract in combination with those given before, it appears that the range of the great Earthquake of April 1762 was from about 16° to 23° North latitude, or from near Cape Negrais to the northward of Calcutta, and from about 87° to 94° East longitude. These limits are I need scarcely remark, by no means certain, but the yare the nearest, which existing information admits of our arriving at. The province of Arracan seems to have been the seat of the greatest intensity of the shock, and the whole eastern coast of the Bay exhibits indications of having experienced its violence. We are fortunate in having such ample details from the province of Chittagong, as they furnish several phenomena of interest which will be discussed hereafter.

The other Earthquakes attributable to the tract now under notice are, as I previously remarked, traditional, and the traditions of their occurrence are confirmed by physical evidence on the coast. But as to their dates or phenomena, I have no information to give.

I may conclude the notice of the Arracan tract by a brief description of the volcanic features of portions of the coast not yet referred to.

I before stated, that in tracing the geographical limits of volcanic regions, Mr. Lyell did not carry that of the Moluccas beyond Barren Island, in latitude 12° N. The only indication of activity furnished by this island when described by Dr. Adam in 1832, consisted in the constant evolution of thin light smoke, (Jour. As. Soc. Vol. I, p. 128,) and ten years later when visited by Capt. Miller, the same effect continued (McClelland's Journal, No. II, p. 423.) No records exist of any intermediate convulsion, either in the form of eruption or earthquake, nor am I aware of the island having exhibited any sympathy with the shocks that have been experienced on the coast of the main land.

Proceeding northward, the Island of Narcaudam, Dr. McClelland informs us, (J. A. S. vol. VII, p. 77,) is a volcanic cone raised to the height of 700 or 800 feet. This cone is situated in 13° 22′ North latitude: "its upper part is quite naked, presenting lines such as were doubtlessly formed by lava currents descending from the crater to the base, which last is covered with vegetation. No soundings are to be found within half a mile from the shore."

Chedooba, in latitude 18° 40′ 55″ has already been described at length. In old charts it is represented as a burning mountain, a circumstance traceable to the intense light which, according to Captain Halsted, is occasionally emitted by the larger mud volcanoes, and which seen from a distance, would make the island appear to be in general eruption.

Ramree, in lat. 19° N. abounds in highly interesting volcanic phenomena. Mud volcanoes similar to those in Chedooba are numerous, and earthy cones of smaller dimensions covered merely with a green

sward, and emitting gas in bubbles, occur in great profusion along the coast. It is an interesting circumstance recorded by Dr. McClelland, that from the summit of one of the largest of these mud volcanoes, called Nayadong, vapour and flame were seen by the inhabitants of Kyook Phoo to issue to the height of several hundred feet above the summit, during the principal shock of the Earthquake of the 26th August 1833. "The phenomenon," Dr. McClelland remarks, "may have been occasioned by the concussion of the Earthquake bursting open some new fissure, from which a transitory stream of inflammable gas, such as supplies the celebrated burning fountain of Chittagong, may have issued."

The mud volcanoes here referred to are precisely similar in their character to those previously described as occurring throughout the coasts of Scinde and Mukran, and farther, to those which have been found on the coasts of Chili and Calabria, two of the most remarkable of modern Earthquake tracts.

Advancing still farther northward, we arrive at the Chittagong coast, where evidences of extensive alterations of level due to volcanic action are no less remarkable. An interesting proof of these is given in the "Mohit," or Ocean, a Turkish work on navigation in the Indian seas, written in 1554, and translated by Von Purgstall, (Jour. As. Soc. Vol. V. p. 466). In this work the author, Sidi, giving detailed instructions for the voyage from Diu to Shattigam, or Bengal, warns navigators with much earnestness against the dangers in their course among the islands on the coast of Chittagong. To the sailing instructions of Sidi, Mr. James Prinsep appends the following note: "There are now no islands seaward of the Chittagong coast to which the sailing directions of Sidi will apply: but Lieut. Lloyd of the Indian Navy, who has surveyed the line, informs us, that there is a long shoal, called 'The Patch,' parallel with the coast, which is nearly dry at low water, and may have formed the islands of Zengilia (referred to by Sidi,) three centuries ago, for there have evidently been great changes in those parts even within the memory of our own navigators."

I am not aware whether the coast of Chittagong generally presents those marked indications of active volcanic forces so strikingly developed throughout that of Arracan, but that such forces do exist beneath it, is proved by the remarkable hot spring about twenty miles to the northward of the town of Chittagong, the gaseous exhalations from which are very considerable, and are frequently in a state of ignition. I have been unable, however, to find any detailed account of the physical structure of this district, and its general character is accordingly unknown to me.

During the year 1843, volcanic action on the Arracan coast was displayed in a rare and interesting manner, by the formation of a new island, but as details of this phenomenon, more ample than any yet published, are to be expected, I defer any remarks upon it to a future opportunity. During the same year, shocks of Earthquake were also

experienced, which will be duly recorded in the Register, the materials for which are not yet arranged.

9. *Earthquakes of the Tract of the Eastern Ghauts.*

The notices of Earthquakes along the line of the Eastern Ghauts which I have been able to procure are few and brief: indeed my information from Southern India generally is of a very limited character, but as there are many intelligent and active cultivators of natural science in that portion of the empire, I do not despair of yet having it considerably extended.

The earliest, as also the most severe recorded shock was experienced at Ongole, (lat. 15° 13′ N., long. 79° 56′ E.) in the year 1800. I am indebted to H. Piddington, Esq. for the following extract from the Asiatic Annual Register for 1801, in which the effects of the Earthquake and its accompanying hurricane are detailed:—

"Extract from a letter dated Ongole, 29th October 1800. We have experienced such exceeding heavy rain at Ongole for the last twenty-four days, that the surface of the country exhibits an entire sheet of water.

"On the 19th instant, about 10 minutes after 4 o'clock A. M., the wind blew a hurricane, when suddenly we felt a severe shock of an Earthquake, which kept the earth in continued agitation for nearly a minute. It shook down many houses, but I believe no person was killed in consequence.

"The Earthquake was introductory to a scene the most painful to my feelings to describe: at about 8 o'clock last night, the wind began to blow strongly with rain, and in about two hours the wind and rain had increased so violently, that the doors and windows were blown open and shivered to atoms.

"In this dreadful situation, it would have been advisable to have quitted our houses for the open plain, but that was impossible, as no one could stand for a moment against the impetuosity of the hurricane, nor would an object be observed at a yard's distance. We trusted in this dilemma to Omnipotence for protection, and placing ourselves in the strongest situations we could think of, we continually heard the trees and walls falling around us.

"The incessant loud claps of thunder, the vivid lightning, the strength of the wind, and the uncommonly heavy rain, were such as the oldest inhabitant never before experienced. The wind blew from the N. E., and continued till two o'clock this morning, when we had an interval of calm till three o'clock, during which we were employed in endeavouring to extricate our cattle from the ruins of the fallen buildings.

"At three o'clock, the storm recommenced from the S. E., and if possible with increased violence, and the houses being at this time all unroofed, we remained till day-break exposed to its utmost fury. When day-light appeared, nothing but death and destruction met the eye in every direction. The ground was covered with dead cattle,

birds, and fallen houses and trees; even the largest banian trees have not escaped: indeed there is scarcely a tree left in the district. It is melancholy to observe the devastation in the villages, and the inhabitants labouring to remove their families and cattle from the ruins."

In his note accompanying the above extract, Mr. Piddington informs me, that Dr. Malcomson, in his Paper in the Geological Transactions on the Basaltic districts of South India, (which I have unfortunately for myself never seen,) mentions, that up to the present time, the tract of country in which Ongole is situated is subject to slight shocks of Earthquake, and internal noises are frequently heard.*

Captain Newbold makes a similar remark relative to the district around Nellore, in which the copper mines are situated, in one of his Papers on the Mineral Resources of Southern India, published in the Journal of the Royal Asiatic Society.

The only other notice of Earthquakes referrible to this tract, is contained in Captain Henderson's Chronological Tables, from which it appears, that on the 15th of June 1837, a severe shock was experienced at Ganjam. No details however are given.

The preceding brief notices constitute the whole of the information relevant to the subject of Earthquakes I have as yet been able to collect from Southern India, and with them, the present summary closes.

I may now state in general terms, the results of the summary as illustrative of the distribution of disturbing forces throughout India and its frontier countries.

The great volcanic region which stretches from the Azores to Central Asia, is not extended by Mr. Lyell, beyond the country bordering the Oxus. From the details previously given, it however appears, that with this region are connected the Earthquake tracts of the Himalayas. We have seen that from the meridian of Herat to that of Assam earthquake shocks, sometimes of great severity, have been experienced along the central axis, and the lateral valleys of the Himalayan chain, and there is every probability therefore, that one great tract of volcanic action extends from the Azores to the eastern limit of these mountains. We still require farther information to enable us to define strictly the termination of the tract on the eastward. Since we know

The extract alluded to is as follows:—H. P.

* On emerging from the gorge in the Nella Malla range, the Pennar enters the plains of the Carnatic, and near its mouth flows through low hills of laterite. This deposit rests on the ordinary granite of the Carnatic, with its associated sienites, hornblende, schist, quartz rock, and mica slate. It is in a rock composed of a mixture of the last two minerals that the copper-mines of the Nellore district are situated. In the same neighbourhood, the sandstone and argillaceous limestone are little elevated above the sea, and are continuous with the same rocks on each side of the Kistnah. They are broken through by insulated basaltic hills, in the neighbourhood of which subterranean sounds and frequent local Earthquakes are reported to occur; an assertion I am the more inclined to believe, having myself experienced two slight shocks during a casual visit to the district.—*Geol. Trans.* Vol. V. N. S.

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that Earthquakes of great violence have frequently devastated China, it is not improbable, that we may yet find this region extending across that country, and ultimately intersecting the train of the Philippines and Moluccas.

Returning to the westward, it would appear that from the eastern shores of the Caspian Sea, the line of volcanic force becomes divided, one portion following the course through the Himalayas just noted, while another diverging to the southward, passes through Persia, along the shores of the Persian Gulf and those of the Arabian Sea, till through Mukran, Scinde and Cutch, it becomes connected with the tract of the Vindhyas, and is thus prolonged across the base of the Indian Peninsula, until it abuts upon the Himalayan line, by means of the mountains bordering Assam.

In this same vicinity, we find the northern limit of the great band of the Moluccas which has been extended through Arracan and Chittagong to the Kassya Mountains, where as formerly adverted to, indications of violent action are remarkably developed. With this portion of the Vindhyan and Molucca bands, are probably connected those forces which have given origin to the Earthquakes of the Gangetic Delta. And these latter may again form the link that joins the tract of the Eastern Ghauts with that of Chittagong, Arracan, and the Malayalan peninsula.

The tract of the Solimaun Mountains connects those of the Himalayas and the Delta of the Indus, while that of the Aravulli would seem to be an off-shoot from the Vindhyas.

Two main lines in which the volcanic forces are distributed throughout India are therefore directly connected with that band which Mr. Lyell has traced from the Western Islands to the shores of the Caspian, while the third is similarly connected with the band that extends from the Aleutian or Fox Islands, in Russian America, to Barren Island in the Bay of Bengal. Nine distinct Earthquake tracts have been specified in this paper: of these two, namely, the central and lateral Himalayan tracts, are the indices of one of the main lines above alluded to; the other two, those of the Delta of the Indus and the Vindhyas, constitute the second, while the third is that of the Eastern Coast of the Bay of Bengal. With the last mentioned, the tracts of the Delta of the Ganges and of the Eastern Ghauts are considered to be connected, and the two remaining tracts, those of the Solimaun and Aravulli mountains, are merely subordinate lines.

Having thus endeavoured to exhibit briefly the results of this summary, I may now conclude by presenting a general Tabular View of Indian Earthquakes, compiled from the materials here collected. A very few shocks have not been referred to specific tracts, because the information relative to them was indistinct, but this may be rectified under more favourable circumstances. *

General Tabular View of Indian Earthquakes.

Focal Tracts.	Number of Earthquakes.	Date of Earthquake.	Remarks.
1. Central Himalayan. ...	1	 1803,	Very severe.
	2	 1809,	Ditto.
	3	26th May 1817,	Ditto.
	4	27th Ditto	Slight.
	5	28th Ditto	Ditto.
	6 to 46	Ditto	Ditto, felt in Kemaon.
	47	25th Dec. 1831,	Ditto.
	48	2nd July 1832,	Ditto.
	49	18th Aug.	Ditto.
	50	23rd Sept.	Ditto.
	51	30th May 1833,	Ditto.
	52	4th Jan. 1835,	Ditto.
	53	14th Jan. 1835,	Ditto.
	54	5th March 1842,	Smart.
	55	7th Sept.	Slight.
2. Lateral Himalayan.			
A. Cabool.	56	 1505,	Very severe.
	57	 1829,	Severe.
	58	 1836,	Slight, several shocks experienced.
	59 to 61	14th Dec. 1837,	Ditto.
B. Jellalabad.	62	19th Feb. 1842.	Very severe.
	63	22nd Feb.	Smart.
	64	23rd Ditto	Ditto, shocks incessantly night and day.
	65	24th Ditto	Ditto.
	66	3rd March	Ditto.
	67	20th April	Ditto.
	68	4th Jan.	Slight.
	69	10th June	Smart.
	70	29th Ditto	Slight.
C. Cashmere.	71	 1552,	
	72	 1780,	Severe.
	73	6th June 1828,	Very severe.
	74	 1831-2,	Severe.
D. Nepaul.	75	 1230,	
	76	 1829,	Smart.
	77	26th Aug. 1833,	Very severe.
	78 to 113	From Aug. to November.....	
E. Assam.	114	14th Jan. 1839,	Slight.
	115	3d June	Ditto.
	116	....	Ditto.
	117	....	Ditto.
	118	14th Jan. 1840,	Ditto.
	119	....	Ditto.
	120	3rd Feb.	Ditto.
	121	4th March	Smart.
	122	9th Feb. 1841,	Smart.
	123	12th Oct.	Slight.
	124	4th Jan. 1842,	Smart.
	125	4th Feb.	Slight.
	126	23rd Oct.	Ditto.
	127	29th Ditto	Ditto.

General Tabular View of Indian Earthquakes.

Focal Tracts.	Number of Earthquakes.	Date of Earthquakes.		Remarks.
3. Solimaun Mountains. ..	128	.....	1831,	Severe.
4. Aravulli Mountains. ..	129	15th June	1505,	Very severe.
	130	July	1720,	Ditto.
	131	24th Oct.	1831,	Smart.
	132	Jan.	1842,	Slight.
	133	....	....	Ditto.
	134	4th July	....	Ditto.
	135	25th July	....	Ditto.
	136	26th Sept.	....	Ditto.
	137	27th Ditto	....	Ditto.
	138	6th Nov.	....	Ditto.
5. Delta of the Indus, ...	139	16th June	1819,	Very severe.
6. Vindhya Mountains. ..	140	B. C. 56.		?
	141	23rd May	1842,	Smart.
	142	24th Ditto	....	Ditto.
7. Delta of the Ganges.	143	11th Oct.	1737,	Very severe.
	144	April	1810,	Smart.
	145	18th Sept.	1829,	Ditto.
	146	....	....	Ditto.
	147	11th Nov.	1842,	Severe.
8. Eastern coast of the Bay of Bengal.	148	2nd April	1762,	Very severe.
	149	....	....	Smart.
	150	....	....	Ditto.
	151	....	....	Ditto.
	152	....	....	Ditto.
	153	....	....	Ditto.
	154	3rd April	....	Slight.
	155	....	....	Ditto.
	156	....	....	Ditto.
	157	....	....	Ditto.
	158	....	....	Ditto.
	159	....	....	Ditto.
	160	....	....	Ditto.
9. Eastern Ghauts.	161	29th Oct.	1800,	Smart.
	162	15th June	1837,	Ditto.

In addition to the shocks registered, an immense number of minor shocks have occured throughout the several tracts.

Comparative Tables of the Law of Mortality, the Expectation of Life, and the Values of Annuities in India and England. By Captain J. C. HANNYNGTON, *24th N. I. 1st Assistant G. G. A. Maunbhome.*

The following Tables have been compiled from those prepared by Major Henderson, Mr. Griffith Davies, and the late Mr. Robert Christie. They exhibit nearly all that is known respecting the Law of Mortality among European Military Officers in India. To facilitate comparison the Northampton and Carlisle Tables are added.

Of the Indian Tables, Major Henderson's is presumed to be the most correct. It was deduced from actual returns for a period of 20 years; and was published with its data in the 17th Vol. of the Transactions of the Asiatic Society. From the age of 75, Major Henderson has adopted the Northampton Table, but has fixed 92 instead of 96 as the limiting age, which prevents literal agreement between the Tables.

Mr. Davies' Table was prepared for the Madras Military Fund, and is founded partly on data furnished by Col. DeHavilland, and partly on Mr. Christie's Table. From the age of 74, Mr. Davies has adopted the Northampton Table.

Mr. Christie's Table was "deduced from a record of 930 Officers, whose dates of appointments, retirements, and deaths he extracted from the books of the Honorable Company at the India House." From the age of 82, Mr. Christie has adopted the Carlisle Table.

The annual per centage of mortality for the Northampton and Carlisle Tables; the expectation of life for Christie's Table; and the values of Annuities at 6 per cent. for all the Indian Tables, have been computed by the writer of this Memorandum. Much care has been taken to render them correct.

TABLE I.—*Exhibiting the Law of Mortality in India and in England, according to various Authorities.*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne—Carlisle.
16	....	11300	5373	....	6261
17	....	11006	5320	....	6219
18	10000	10705	5262	....	6176
19	9741	10394	5199	...	6133
20	9489	10077	5132	....	6090
21	9243	9761	5060	....	6047
22	9004	9446	4985	....	6005
23	8771	9136	4910	....	5963
24	8501	8830	4835	....	5921
25	8239	8529	4760	....	5879
26	7985	8234	4685	....	5836
27	7739	7944	4610	....	5793
28	7501	7660	4535	....	5748
29	7246	7381	4460	....	5698
30	7000	7108	4385	....	5642
31	6762	6841	4310	....	5585
32	6532	6581	4235	....	5528
33	6310	6328	4160	....	5472
34	6080	6083	4085	....	5417
35	5859	5847	4010	....	5362
36	5646	5619	3935	...	5307
37	5441	5399	3860	....	5251
38	5243	5187	3785	....	5194
39	5034	4983	3710	....	5136
40	4833	4787	3635	6655	5075
41	4640	4598	3559	6557	5009
42	4455	4416	3482	6458	4940
43	4277	4241	3404	6356	4869
44	4093	4072	3326	6253	4798
45	3917	3909	3248	6146	4727
46	3748	3753	3170	6037	4657
47	3587	3602	3092	5925	4588
48	3432	3457	3014	5810	4521
49	3281	3317	2936	5691	4458
50	3136	3182	2857	5570	4397
51	2998	3052	2776	5446	4338
52	2866	2926	2694	5318	4276
53	2740	2804	2612	5188	4211
54	2628	2687	2530	5054	4143
55	2520	2573	2448	4916	4073
56	2417	2464	2360	4776	4000
57	2318	2358	2284	4632	3924
58	2223	2256	2202	4486	3842
59	2120	2158	2120	4338	3749
60	2022	2063	2038	4187	3643
61	1929	1971	1956	4034	3521
62	1840	1882	1874	3879	3395
63	1755	1796	1793	3722	3268
64	1639	1713	1712	3564	3143
65	1531	1632	1632	3405	3018
66	1430	1553	1552	3244	2894
67	1336	1476	1472	3082	2771
68	1248	1399	1392	2921	2648
69	1114	1321	1312	2759	2525
70	994	1241	1232	2593	2401

TABLE I.—*Exhibiting the Law of Mortality in India and in England, according to various Authorities,—(Continued.)*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne — Carlisle.
71	887	1161	1152	2424	2277
72	792	1079	1072	2253	2143
73	707	996	992	2081	1997
74	631	913	912	1907	1841
75	563	832	832	1737	1675
76	495	752	752	1571	1515
77	429	675	675	1410	1359
78	366	602	602	1255	1213
79	366	534	534	1109	1081
80	248	469	469	971	953
81	179	406	406	843	837
82	154	346	346	725	725
83	118	289	289	623	623
84	88	234	234	529	529
85	66	186	186	445	445
86	49	145	145	367	367
87	36	111	111	296	296
88	25	83	83	232	232
89	16	62	62	181	181
90	9	46	46	142	142
91	4	34	34	105	105
92	1	24	24	75	75
93	....	16	16	54	54
94	....	9	9	40	40
95	....	4	4	30	30
96	....	1	1	23	23
97	....	....	....	18	18
98	....	....	....	14	14
99	....	....	....	11	11
100	....	....	....	9	9
101	....	....	....	7	7
102	....	....	....	5	5
103	....	....	....	3	3
104	....	....	....	1	1

TABLE II.—*Shewing the Annual rate per cent. of Mortality in India and England.*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne—Carlisle.
16	....	2.60	0.99	....	0.67
17	....	2.73	1.09	....	0.69
18	2.52	2.90	1.20	....	0.70
19	2.73	3.05	1.29	....	0.70
20	2.79	3.14	1.40	....	0.71
21	2.85	3.23	1.48	....	0.69
22	2.90	3.28	1.50	....	0.70
23	2.96	3.35	1.53	....	0.70
24	3.02	3.41	1.55	....	0.71
25	3.09	3.46	1.58	....	0.73
26	3.14	3.52	1.60	....	0.74
27	3.21	3.57	1.63	....	0.78
28	3.27	3.64	1.65	....	0.87
29	3.31	3.70	1.68	....	0.98
30	3.35	3.76	1.71	....	1.01
31	3.40	3.80	1.74	....	1.02
32	3.44	3.84	1.77	....	1.01
33	3.49	3.87	1.80	....	1.01
34	3.53	3.88	1.84	....	1.02
35	3.58	3.90	1.87	....	1.03
36	3.62	3.91	1.91	....	1.04
37	3.67	3.93	1.94	....	1.09
38	3.72	3.93	1.98	....	1.12
39	3.76	3.93	2.02	....	1.19
40	3.81	3.95	2.09	1.47	1.30
41	3.86	3.96	2.16	1.51	1.38
42	3.90	3.96	2.24	1.58	1.44
43	3.95	3.98	2.29	1.62	1.46
44	3.99	4.00	2.35	1.71	1.48
45	4.03	3.99	2.40	1.77	1.48
46	4.08	4.02	2.46	1.85	1.48
47	4.12	4.03	2.52	1.94	1.46
48	4.16	4.05	2.59	2.05	1.39
49	4.23	4.07	2.69	2.13	1.37
50	4.29	4.08	2.84	2.23	1.34
51	4.38	4.13	2.95	2.35	1.43
52	4.44	4.17	3.04	2.44	1.52
53	4.52	4.17	3.14	2.58	1.61
54	4.59	4.24	3.24	2.73	1.69
55	4.67	4.24	3.35	2.85	1.79
56	4.76	4.30	3.47	3.02	1.90
57	4.84	4.33	3.59	3.15	2.08
58	4.92	4.34	3.72	3.30	2.42
59	4.99	4.40	3.87	3.48	2.83
60	5.07	4.46	4.02	3.65	3·35
61	5.15	4.51	4.19	3.84	3.58
62	5.43	4.57	4.32	4.05	3.74
63	5.75	4.62	4.52	4.25	3.82
64	6.09	4.73	4.67	4.46	3.98
65	6.49	4.84	4.90	4.73	4.11
66	6.95	4.96	5.15	4.99	4.25
67	7.46	5.22	5.43	5.22	4.44
68	8.06	5.57	5.74	5.55	4.65
69	8.77	6.06	6.10	6.02	4 92
70	9.61	6.45	6.49	6.52	5.16

TABLE II.—*Shewing the Annual rate per cent. of Mortality in India and England.—(Continued.)*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne—Carlisle.
71	10.2	7.06	6.94	7.05	5.88
72	10.8	7.69	7.46	7.63	6.81
73	11.2	8.33	8.06	8.36	7.81
74	12.1	8.87	8.77	8.91	9.02
75	13.4	9.62	9.62	9.56	9.55
76	14.7	10.24	10.24	10.25	10.30
77	16.4	10.81	10.81	10.99	10.74
78	19.0	11.30	11.30	11.63	10.88
79	20.5	12.17	12.17	12.44	11.84
80	22.0	13.43	13.43	13.18	12.17
81	23.4	14.78	14.78	13.99	13.38
82	25.2	16.47	16.47	14.07	14.07
83	25.3	19.03	19.03	15.09	15.09
84	25.8	20.51	20.51	15.88	15.88
85	26.0	22.04	22 04	17.53	17.53
86	29.4	23.45	23.45	19.34	19.34
87	33.3	25.22	25.22	21.62	21.62
88	43.7	25.30	25.30	21.99	21.99
89	55.5	25.81	25.81	21.55	21.55
90	75.0	26.09	26.09	26.06	26.06
91	100.0	29.41	29.41	28 57	28.57
92	....	33.33	33.33	28.00	28.00
93	....	43.75	43.75	25.93	25.93
94	....	55.56	55.56	25.00	25.00
95	....	75.00	75.00	23.33	23.33
96	....	100.00	100.00	21.74	21.74
97	....	....	....	22.22	22.22
98	....	....	....	21.43	21.43
19	....	....	....	18.18	18.18
100	....	....	....	22.22	22.22
101	....	....	....	28.57	28.57
102	....	....	....	40.00	40.00
103	....	....	....	66.67	66.67
104	....	....	....	10.000	100.00

TABLE III.—*Shewing the Expectation of Life in India and England.*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne—Carlisle.
16	....	24.72	35.85	....	44.27
17	....	24.37	35.20	....	43.57
18	24.76	24.04	34.58	....	42.87
19	24.40	23.75	33.99	....	42.17
20	24.04	23.48	33.43	....	41.46
21	23.67	23.22	32 90	....	40.75
22	23.28	22.98	32.39	....	40.04
23	22.89	22.74	31.88	....	39.31
34	22.60	22.52	31.36	....	38.59
25	22.30	22.29	30.85	....	37.86
26	22.00	22.07	30.33	....	37.14
27	21.68	21.86	29.82	....	36.41
28	21.35	21.65	29.30	....	35.69
29	21.08	21.45	28.79	....	35.00
30	20.81	21.26	28.27	....	34.34
31	20.52	21.07	27.76	....	33.68
32	20.23	20.88	27.24	....	33.03
33	19.92	20.69	26.72	....	32.36
34	19.66	20.51	26.20	....	31.68
35	19.38	20.32	25.68	....	31.00
36	19.09	20.12	25.16	....	30.32
37	18.79	19.92	24.64	....	29.64
38	18.48	19.71	24.12	....	28.96
39	18.23	19.50	23.60	....	28.28
40	17.97	19.28	23.08	25.35	27.61
41	17.69	19 05	22.56	24.48	26.97
42	17.41	18.81	22.04	23.85	26.34
43	17.11	18.57	21.54	23.23	25.71
44	16.86	18.32	21.03	22.60	25.09
45	16.59	18.06	20.52	21.99	24.46
46	16.32	17.79	20.02	21.38	23.82
47	16.03	17.52	19.51	20.77	23.17
48	15.73	17.23	19.00	20.17	22.50
49	15·43	16.94	18.49	19.58	21.81
50	15.12	16.63	17.99	19.00	21.11
51	14.80	16.32	17.50	18.42	20.39
52	14.45	16.00	17.02	17.85	19.68
53	14·10	15.68	16.54	17.29	18.97
54	13.67	15.34	16.06	16.73	18.28
55	13.24	14.99	15.58	16.19	17.58
56	12.78	14.63	15.10	15.65	16.89
57	12.31	14.27	14.63	15.12	16.21
58	11.81	13.89	14.15	14.59	15.55
59	11.36	13.50	13.68	14.07	14.92
60	10.88	13.10	13.21	13.56	14.34
61	10.39	12.69	12.75	13.06	13.82
62	9.87	12.26	12.28	12.56	13.31
63	9.32	11.83	11.81	12.07	12.81
64	8.94	11.38	11.35	11.58	12.30
65	8.55	10.92	10.88	11.10	11.79
66	8.11	10.45	10.42	10.63	11.27
67	7.64	9.96	9.96	10.16	10.75
68	7.15	9.48	9.50	9.69	10.23
69	6.95	9.02	9.05	9.23	9.70
70	6.73	8.56	8.60	8.79	9.18

TABLE III.—*Shewing the Expectation of Life in India and England,—(Continued.)*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne—Carlisle.
71	6.47	8.12	8.17	8.37	8.65
72	6.20	7.72	7.74	7.97	8.16
73	5.88	7.31	7.33	7.58	7.72
74	5.53	6.92	6.92	7.23	7.33
75	5.13	6.54	6.54	6.89	7.01
76	4.77	6.18	6.18	6.56	6.69
77	4.43	5 83	5.83	6.25	6.40
78	4.41	5.48	5.48	5.97	6 12
79	3.81	5.11	5.11	5.68	5.80
80	3.59	4.75	4.75	5.42	5.51
81	3.39	4.41	4.41	5.17	5.21
82	3.19	4.09	4.09	4.92	4.93
83	3.01	3.80	3.80	3.65	4.65
84	2.87	3.58	3.58	4.39	4.39
85	2.66	3 37	3.37	4.12	4.12
86	2.40	3.19	3.19	3.90	3.90
87	2.08	3.01	3.01	3.71	3.71
88	1.80	2.86	2.86	3.59	3.59
89	1.50	2.66	2.66	3.47	3.47
90	1.22	2.41	2.41	3.28	3.28
91	1.00	2.09	2.09	3.26	3.26
92	0.50	1.75	1.75	3.37	3.37
93	0.00	1.37	1.37	3.48	3.48
94	....	1.05	1.05	3.53	3.53
95	....	0.75	0.75	3.53	3.53
96	....	0.50	0.50	3.46	3.46
97	....	0.00	0.00	3.28	3.28
98	....	....	....	3.07	3.07
99	....	....	....	2.77	2.77
100	...	....	....	2·28	2.28
101	....	....	....	1.79	1.79
102	....	....	....	1.30	1.30
103	....	....	....	0.83	0.83
104	....	....	....	0.00	0.00

TABLE IV.—*Shewing the Value of an Annuity on a Single Life, according to Indian and English Tables. Interest being 6 per cent.*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne—Carlisle.
16	....	10.314	12.755	....	14.067
17	....	10.225	12.655	....	14.012
18	10.526	10.144	12.562	....	13.956
19	10.454	10.074	12.477	....	13.897
20	10.376	10.014	12.398	....	13.835
21	10.291	9.959	12.329	....	13.769
22	10.198	9.908	12.265	....	13.697
23	10.097	9.859	12.200	....	13.621
24	10.040	9.813	12.132	....	13.541
25	9.981	9.769	12 063	....	13.456
26	9.916	9.726	11.992	....	13.368
27	9.846	9.686	11.917	....	13.275
28	9.770	9.647	11.841	....	13.182
29	9.720	9.613	11.763	....	13.096
30	9.666	9.581	11.682	....	13.020
31	9.606	9.552	11.598	....	12 942
32	9.541	9.528	11.512	....	12.860
33	9.470	9.503	11.423	....	12.771
34	9.417	9.479	11.331	....	12.675
35	9.359	9.453	11.236	....	12.573
36	9.295	9.427	11.137	....	12.465
37	9.224	9.400	11.035	....	12.354
38	9.147	9.371	10.929	....	12.239
39	9.098	9.340	10.819	....	12.120
40	9.045	9.306	10.705	11.369	12.002
41	8.986	9.270	10.589	11.232	11.890
42	8.921	9.231	10.473	11.088	11.779
43	8.850	9.189	10.356	10.942	11.668
44	8.803	9.144	10.235	10.790	11.551
45	8.750	9.097	10.110	10.636	11.428
46	8.693	9.044	9.980	10.478	11.296
47	8.628	8.988	9.846	10.316	11.154
48	8.559	8.925	9.707	10.152	10.998
49	8.490	8.859	9.563	9.986	10.823
50	8.416	8.789	9.417	9.815	10.631
51	8.331	8.713	9.273	9.640	10.422
52	8.238	8.634	9.129	9.465	10.208
53	8.134	8.550	8.980	9.285	9.988
54	7.989	8.458	8.827	9.101	9.761
55	7.832	8.363	8.670	8.920	9.524
56	7.655	8.257	8.509	8.732	9.280
57	7.461	8.145	8.343	8.544	9.027
58	7.247	8.024	8.173	8.351	8.772
59	7.055	7.892	7.999	8.154	8.529
60	6.841	7.751	7.820	7.951	8.304
61	6.601	7.600	7.637	7.752	8.108
62	6.335	7.436	7.449	7.546	7.913
63	6.040	7.260	7.253	7.336	7.714
64	5.856	7.069	7.052	7.121	7.502
65	5.645	6.865	6.841	6.900	7.281
66	5.407	6.647	6.625	6.778	7.049
67	5.134	6.413	6.405	6.450	6.803
68	4.826	6.172	6.179	6.214	6.546
69	4.731	5.929	5.949	5.974	6.277
70	4.620	5.689	5.716	5.738	5.998

TABLE IV.—*Shewing the Value of an Annuity on a Single Life, according to Indian and English Tables. Interest being 6 per cent.—(Continued.)*

Age.	Henderson for Indian Army.	Davies for Madras Army.	Price—Northampton.	Christie for Retired Indian Officers.	Milne—Carlisle.
71	4.488	5.446	5.479	5.506	5.704
72	4.328	5.212	5.241	5.279	5.424
73	4.139	4.985	5.004	5.059	5.170
74	3.916	4.764	4.769	4.851	4.944
75	3.652	4.542	4.542	4.645	4.760
76	3.403	4.326	4.326	4.445	4.579
77	3.163	4.109	4.109	4.250	4.410
78	2.929	3.884	3.884	4.061	4.238
79	2.714	3.641	3.641	3.959	4.040
80	2.550	3.394	3.394	3.792	3.858
81	2.402	3.156	3.156	3.630	3.656
82	2.258	3.926	3.926	3.474	3.474
83	2.123	2.713	2.713	3.286	3.286
84	2.018	2.551	2.551	3.102	3.102
85	1.851	2.402	2.402	2.909	2.909
86	1.642	2.266	2.266	2.739	2.739
87	1.369	2.138	2.138	2.599	2.599
88	1.090	2.031	2.031	2.515	2.515
89	0.806	1.882	1.882	2.417	2.417
90	0.518	1.689	1.689	2.266	2.266
91	0.236	1.422	1.422	2.248	2.248
92	0.000	1.136	1.136	2.337	2.337
93	....	0.806	0.806	2 440	2.440
94	....	0.518	0.518	2.492	2.492
95	....	0.236	0.236	2.522	2.522
96	....	0.000	0·000	2.486	2.486
97	....	....	....	2.368	2.368
98	....	....	....	2.227	2.227
99	....	....	....	2.004	2.004
100	....	....	....	1.596	1.596
101	....	....	....	1.175	1.175
102	....	....	....	0.744	0.744
103	....	....	....	0.314	0.314
104	....	....	....	0.000	0.000

Experiments and Papers, principally by W. B. O'Shaughnessy, Esq. *B. M. S. relating to the effects of Sea-water on Iron. Communicated by the Government of Bengal.*

No. 2556.

From the Under-Secretary to the Government of Bengal, to H. Torrens, Esq. *Secretary to the Asiatic Society, dated Fort William, 30th October,* 1843.

Sir,—I am directed by the Deputy Governor of Bengal to forward copy of a letter from the Superintendent of Marine, No. 591, dated the 23d ultimo, and its original enclosures, relative to the corrosive effects of Salt-water on Iron, with His Honor's permission for the publication of the whole, or any part of the information therein contained on this highly important subject. I have, &c.

(Signed) Cecil Beadon,
Under-Secretary to the Government of Bengal.

(Copy.) No. 591.

From Major A. Irvine, *Superintendent of Marine, to the Hon'ble* W. W. Bird, *Deputy Governor of Bengal, dated Fort William, 23rd September,* 1843.

Honorable Sir,—On the receipt of Mr. Secretary Bushby's letter, No. 198, dated 10th March 1841, a correspondence was entered into with Dr. O'Shaughnessy, copy of which, as per margin, I have now the honor to forward, together with copy of a letter, No. 1156, dated 24th July, from the Superintendent of the Indian Navy.

Letter to Dr. O'Shaughnessy, No. 1246, dated 13th April, 1841.
Do. do. No. 599, dated 28th August.
Do. from do. dated 31st August.
Do. do. do. dated 23rd November with Enclosures.

2nd. Copy of this very interesting report was forwarded to the Controller of Government Steam Vessels, and I am now induced to send it to your Honor, under the idea that it may not be considered inexpedient to permit its publication in some of the periodical works of this Presidency. I have, &c.

(Signed) A. Irvine,
Superintendent of Marine.

(True Copy.)

(Signed) Cecil Beadon,
Under-Secretary to the Government of Bengal.

No. 1246.

To Dr. W. B. O'Shaughnessy.

Sir,—In continuation of my letter, No. 1076, dated the 26th ultimo, I am directed by the Marine Board to forward to you, for your information, the accompanying copy of a letter, dated the 3rd instant, from the Acting Assistant Master Attendant at Madras, relative to the corrosive effects of Sea-water on Iron. I have, &c.

Fort William, Marine Board (Signed) C. B. Greenlaw,
Office, the 13*th April*, 1841. *Secretary.*

Fort William, Marine Superintendent's Office,
the 23*rd Sept.* 1843. (True Copy.)
(Signed) C. B. Greenlaw, *Secretary.*

No. 599.

To Dr. W. B. O'Shaughnessy, *Chemical Examiner.*

Sir,—With reference to my letters as per margin, I am directed by the Marine Board to request you will be good enough to report whether you have made any experiments with a view to ascertain the effects of Sea-water on Iron; and if so, the Board will feel obliged by your favoring them with the result of such experiments.

No. 256 dated 21st Jan. 1841.
,, 710 ,, 25th Feb. ,,
,, 874 ,, 11th March ,,
,, 1076 ,, 26th ,, ,,
,, 1246 ,, 13th April ,,

Fort William, Marine Board } I have, &c.
Office, the 28*th August*, 1841. } (Signed) C. B. Greenlaw,
Fort William, Marine Superintendent's Office, *Secretary.*
the 23*rd Sept.* 1843. (True Copy.)
(Signed) C. B. Greenlaw, *Secretary.*

C. B. Greenlaw, Esq. *Secretary to the Marine Board.*

Sir,—In reply to your letter, No. 599, I beg leave to state, that I have completed a very extensive series of experiments on the effects of Sea-water on Iron. The results I trust will be found of some interest and usefulness. The voluminous notes of the experiments required to be reduced to order and copied, I fear much I can scarcely undertake to lay my report before the Board before the end of next

month, but if it be deemed emergently requisite, I will endeavour, at any inconvenience, to comply with the Board's wishes.

Calcutta, 31st August, 1841. I have, &c.

(Signed) W. B. O'Shaughnessy,
Chemical Examiner.

Fort William, Marine Superintendent's Office,
the 23d Sept. 1843. (True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

C. B. Greenlaw, Esq. *Secretary to the Marine Board.*

Sir,—In continuation of a previous letter, I have the honor to resume the subject of the corrosion of Sea-going Iron Vessels, and the best means of its prevention.

2d. There exists no material difference in the constitution of the several waters you forwarded to me for analysis, or which I received from time to time from other sources, beyond a variable degree of dilution with fresh water from the influence of the tides.

3d. The object of my experiments, was to ascertain the comparative rate of corrosion effected by the waters of Saugor, the Bay of Bengal, and Kyook Phoo, the nature of the corrosion, and the best means of its prevention.

Rate of Corrosion.

4th. For the first object, pieces of sheet iron of six inches long, three broad, and accurately weighed, were immersed in the water in glass vessels, slightly covered to check evaporation, any loss from this cause being made up by rain water from time to time. The result of very numerous experiments conducted on this plan, is, that the rate of corrosion is exactly the same in all the waters under experiment, in a period of six months, being as nearly as possible 5 grains loss from each superficial foot daily.

5th. The influence of size of the plates was examined as far as opportunities permitted, by arranging sets of iron sheets, all in metallic contact, in the manner shewn in the accompanying diagram.* From

* The sheets of iron being merely arranged vertically, it has not been thought necessary to add the diagram.

experiments conducted in this way, the corrosion was found to increase, in an arithmetical proportion to the increase of the surface exposed. These experiments were carried as far as the exposure of 100 superficial feet.

6th. The influence of density was also studied, both on the waters sent by the Marine Board, and artificial saline solutions. The general result is, that so long as the temperature continues the same, no difference of corrosion occurs *within the limits of the natural variations in the density of the sea-water under experiment.*

The nature of the Corrosion.

7th. This is simple oxidation, the red oxide of iron being deposited in loose flakes on the exposed surface. The presence of air in the water accelerates the commencement of the action, but is not essential to its continuance. I have found that corrosion will not occur in boiled distilled water, hermetically sealed up. It takes place more slowly in salt-water, previously boiled, and then hermetically sealed up; and it occurs in the ordinary manner in common salt-water, not boiled, but secluded from access of air.

Obviation of Corrosion.

8th. The experiments made on this head may be classified as follows:—

a. Protection by Galvanic action.

b. Protection by Cements.

c. Protection by Varnishes.

9th. *a.* The experiments on this head were very numerous, and may be thus described.

Pieces or arrangements of sheet iron, ranging from eight superficial inches to 100 superficial feet, were tried for equal periods with zinc protectors, ranging from an equal size to one-hundreth the size of the sheet iron. The results I obtained are as follow:—

10th. For the protection of the iron the zinc must undergo corrosion, and when this ceases from any cause, the iron is attacked as usual. The corrosion or loss of 60 grains of zinc daily protects 100 superficial feet of iron, less than this will not suffice. On the other hand, increasing the surface of the zinc protectors increases the amount of corrosion of

the zinc, without giving greater protection. The practical inference is, that *the protectors should be massive, but of small surface,* and placed where they can be conveniently renewed; further, that it is an error to suppose, that merely zincing the heads of nails or rivets would suffice; such a method would be worse than useless, for the quantity of zinc thus used, would be insufficient to sustain the protection, and the corrosion which follows always commences at the points of contact with the late protector, thus endangering a vessel in its most important parts.

The zinc undergoes oxydation. If moving through sea water the oxyde is washed off and dissolved;—if quiescent, the oxyde is deposited in a spongy white coating on the iron. Besides oxydation the zinc also suffers considerable loss by its structure becoming granular and brittle, and readily disintegrated by friction.

11th. I have tried many other metals beside zinc, and found only one superior to it in protecting power. This is CADMIUM, which presents advantages of extraordinary value, were these not counterbalanced by the scarcity and dearness of the metal. While cadmium protects the iron with equal energy, its own corrosion is little more than one-third that of the zinc, and instead of becoming granular and incoherent like the zinc, its surface is always bright and solid. The present price of cadmium of course forbids its employment; but the high price I believe is attributable to there having been hitherto no *use* discovered for the article, which exists to the amount of 3 per 100 in many of the zinc ores of Great Britain. Were cadmium cheaply obtainable, it would at once be resorted to as an iron protector; its influence on copper I have not yet studied.

Protection of Tin Plate.

12th. I have extended this enquiry to the protection of tin plate, and with rather interesting results. Tin plate is perfectly protected by proportionally much smaller quantities of *zinc* than are required for iron. The surface of the tin fouls very slowly, the fouling is caused by the diffusion over it of the oxide of zinc. This is readily removed by washing it, by a brush or coir scrubber, with a weak alkaline liquid (a solution of one lb of *saji-mati* in 4 pounds of water is sufficient). This fact I represent as one of considerable value, and calculated to lead to much economy in the construction of buoys for Salt-water harbours,

and for the sheathing of boats and other small crafts, which can be hauled up from time to time. I beg to observe, that these remarks do not apply to fresh water buoys or boats. In fresh water, the tinned iron suffers corrosion, notwithstanding the presence of the zinc.

Cements and Varnishes.

13th. The plates forwarded to me by your Board from Captain Kinsman were immersed in Sea-water. In a week all began to soften, and in 14 days corrosion of the iron was taking place through the pores in the substance of the cement. I consider this method quite inapplicable from these and many other reasons.

14th. *Caoutchouc.*—This I applied in various forms. I find to my surprise that by three weeks' immersion, it softens so as to be detached by the slightest friction.

15th. *Asphaltum.*—This invaluable substance completely protects the iron if *rubbed on while hot:* it resists even strong nitric acid for months. But the application requiring the heating of the iron, opposes a great practical difficulty to its use. I find by mixing a small quantity (about one-eighth its weight) of fine sifted road dust with the asphaltum while melted, that it will adhere to the cold iron. It should be laid on by a wire brush, as no hair, or coir, or yarn brush will stand the heat. Practical men in the dock-yards can soon turn this fact to account.

16th. *Coal Tar* answers well as a retarder rather than a preventer of corrosion, provided all the volatile oil of the tar is entirely expelled by heat or exposure to the air, before the immersion of the iron. If this be neglected, the varnish soon washes away.

17th. *Coal Tar* boiled with one-eighth asphaltum gives an excellent protecting varnish, and one which can be applied to cold iron, and which dries much more perfectly than the coal-tar alone.

18th. Along with those above-mentioned, I have tried many others, such as the *Gab juice,* white and red lead paint, &c. but none approached in efficacy the articles above cited. Asphaltum is procurable cheaply from the Persian Gulf, whence it is occasionally imported into Calcutta under the name of *Zift-i-Roomie.* Purchasers not knowing its exact qualities, will have boiled pitch palmed on them instead, by the bazar venders. A simple test is exposure to the sun for from five to

ten minutes, according to the season; while this scarcely affects the asphaltum, it softens the pitch into a ductile mass.

Fouling by Marine Animals and Plants.

19th. This serious evil, so familiar to navigators, and so importantly exemplified in many of the papers submitted with this report, (see the statements regarding the *Phlegethon*, the *Sylph*, &c.) has of course engaged my attention, but as yet has led to no important results. Several proposals have been made to prevent this by the use of *poisonous* paints of different kinds. I do not anticipate much benefit from the proposal. If the paints are soluble in water, they must wash off. If insoluble, they are not likely to exercise any poisonous power. The simplest way to test this would be, by immersing a log of nux-vomica wood in Kyouk Phoo harbour, or any other place infested with the Balani or Teredo.

Singular inactivity of the water of the Baleaghaut Salt-works on tin plates.

20th. While carrying on the experiments on tin plate, my stock of Sea-water having been exhausted, I procured a quantity of brine in various stages of concentration from the Salt-works at Baleaghaut. Tin plate immersed without protectors in this water, underwent no change in four months, and the corrosion of iron was much retarded, though not entirely prevented. The water was rich in organic matter, and gradually became mouldy, as the experiments proceeded. This singular fact opens a most interesting field for investigation, which I regret much I have no longer the opportunity to pursue.

Mr. Mallet's Experiments.

21st. When my experiments were nearly completed, a report on those carried on for five years, and on a much larger scale, by Mr. Mallet in Dublin, reached this country, in the last volume of the "Proceedings of the British Association." Mr. Mallet's copious tables of results correspond so exactly with mine, that it becomes superfluous for me to encumber your Board with details. I send the volume containing the report, and which deserves the close attention of the Marine Board, and of all Engineers connected with sub-marine-works in iron.

22d. I forward also several papers which have reached me on this subject, and in which many facts and observations of much interest will be found.

23d. Lastly, I have to express my regret that in consequence of the state of my health compelling me to return to Europe immediately, I have not the leisure to present a more complete Report on this very interesting subject.* I have, &c.

(Signed) W. B. O'Shaughnessy, *M. D.*

Calcutta, the 23d November, 1841. *Chemical Examiner.*

Memorandum of Papers appended.

1. Capt. Kinsman on a poisonous Cement.
2. ,, Henderson, communicating various facts.
3. ,, Williams of the "*Sylph*," ditto ditto.

4, 5, 6. Capt. Cleaveland's Abstracts of the voyage of the Iron Steamer "*Phlegethon.*"

7. Mr. Johnson's observations on the corrosion of iron in the *Phlegethon*, communicated by Mr. Maddock.

(True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

Fort William, Marine Superintendent's Office, the 23d Sept. 1843.

To E. A. Blundell, Esq. *Commissioner in the Tenasserim Provinces.*

Sir,—Having been requested by you to give my opinion regarding the corrosive effects water may have on iron in these seas, I beg to state that I am of opinion, water in these seas is as destructive to iron as in any part of the world.

* The proofs of this report have been submitted to Dr. O'Shaughnessy for revision and correction.—Eds.

I have the honor to inform you of one particular instance which came under my notice about three years ago. When at anchor in the "*Swinton*," a little below your wharf, a large Burman boat hooked a chain, the original size of which must have been upwards of an inch in diameter, and was lost with the Brig "*Macaulay*" about ten years previous; it was completely eaten away with rust, and broke with its own weight in two fathoms of water; it must be taken into consideration that this chain was lying in *fresh* water more than half the time above-mentioned.

As the tenor of your letter leads me to suppose that an object would be gained by preventing corrosion on the bottom of iron steamers only, I beg to forward three experiments of mine on sheet iron, the ingredients are the same in each, but differ in quantity.

No. 1 has two measures of dammer and one of chunam, with one-sixteenth measure or less of *artol*, (or crude arsenic,) each pounded separately and sifted through a fine sieve, to which is added a sufficient quantity of wood-oil, and then well pounded together until it becomes in substance a stiff paste.

Directions for using the above.

Heat the bottom of the vessel as on common occasions, and lay it on with the hand, warm towels should immediately follow, which will make it as smooth as may be required, and the vessel may be floated as soon as finished; each coat I feel certain will remain good under water longer than any other composition yet known.

The qualities of inferior composition have often been proved under water on wood, with the exception of *artol*, but barnacles will adhere to it, which the *artol* will prevent.

On receiving your letter, I was doubtful whether the composition would adhere to iron, which doubt I trust has now been removed by the experiments now forwarded.

No. 2 has one measure of dammer and one of chunam, with the same proportion of *artol*. No. 3 has three measures of chunam, and one measure of dammer mixed and prepared as the above.

Moulmein, 1st December, 1840.

I have, &c.

(Signed) Thos. Kinsman,

Commander H. C. Schr. "Swinton."

P.S.—While using the above composition, the pounding of it should not cease, otherwise the substance will become hard.

(True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

Fort William, Marine Superintendent's Office, the 23d Sept. 1843.

To Dr. O'Shaughnessy, *Medical College.*

20th May.

My dear Sir,—I have been engaged for sometime at home in obtaining information as to the best means of preventing corrosion of Iron Sea-going Vessels, and had contracted to build an iron opium clipper, but waited to see the effect of the barnacle and limpet on the iron sides in three voyages from Liverpool to the Brazils. On docking her on her first return, you could not put the palm of the hand on her bottom clear of a limpet. On the second return, I could not find room for the ball of my thumb, so completely covered was it. The first voyage she was painted with red lead and linseed oil, the second some white lead was added, and the third voyage she was offered for sale in consequence of the inability to keep the bottom from getting so very foul, as to reduce her sailing qualities far below a common merchant ship, though she was a fast vessel.

The *Leviathan* Steamer, 2700 tons, building at Bristol, I visited, and saw experiments being made with 8 or 10 different compositions. The builder told me they had tried near 40, and I dare say by this time something will have been discovered.

I am a member of the institution of Civil Engineers, and will write to the Secretary next mail, to ascertain what has been done or discovered, and inform you of the result.

As to the copper, it had a bar of iron along the keel, and up and down stern and stern-posts. We had it on our voyage to China. The iron was destroyed in two years, I think, and I never renewed it. The copper lasted eleven years; with exception of her voyage to China and to Suez, she was running in the Hooghly. The patent yellow metal, or Muntz's patent, much used now for shipping, being about 20 per cent.

cheaper, (first cost,) is not superior to copper in any way. The zinc is not used now; I suppose from its so soon corroding, and in fact becoming rotten.

I shall be glad to afford you any information in my power, and am,

Yours, &c.

(Signed) Andrew Henderson.

Dr. O'Shaughnessy, *Medical College.*

(True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

Fort William, Marine Superintendent's Office, the 23d Sept. 1843.

To M. Rustomjee, Esq.

Dear Sir,—When the "*Sylph*" was docked after her return from the coast of China last December, we found her copper covered with large barnacles in clusters, although after she came in fresh water a great many had dropped off, but left the mark where they had been. The copper was likewise all in small holes, and rusted at the edges, the same as a piece of iron, a great quantity of which I think was mixed with the copper, which caused the barnacles and sea-weed to adhere, amongst which, when on the coast, were a large quantity of long worms resembling centipedes, but much smaller.

I remain, &c.

May 18, 1841. (Signed) T. Williams.

(True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

Fort William, Marine Superintendent's Office, the 23rd Sept. 1843.

H. C. S. Vessel "Phlegethon," Calcutta, May 27, 1841.

Sir,—In reply to your letter of the 24th May, I beg to assure you I shall have great pleasure in affording all the information in my power on the effects of the voyage on our Iron Vessel.

The "*Phlegethon*" left England with a clean bottom, having when on the slip received three coats of red lead and three of black varnish, which with an additional coating we partly succeeded in putting on at the Mozambique, will I hope be found to have entirely preserved the iron from corrosion, as at Mozambique I observed the coatings of red lead remained perfect, when the blacking had been worn off.

The first barnacles appeared and rapidly increased after crossing the Tropic, with another species, I think called the Teredo.

These were invariably scraped off on the arrival of the vessel in port, as well as a narrow belt of soft green weed, of which the water line was the margin, and the depth 8 to 9 inches, and of most rapid growth.

These obstructions to the vessel's sailing have, in from three to five weeks, become very great, reducing her rate of sailing frequently one-ninth, and occasionally upwards.

The barnacles are fast disappearing since our arrival in fresh water.

I have, &c.

(Signed) R. F. Cleaveland.

W. B. O'Shaughnessy, *M. D.*

(True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

Fort William, Marine Superintendent's Office, the 23d Sept. 1843.

(Copy.)

To T. H. Maddock, Esq.

Dear Sir,—I beg to have the honor of laying before you, a few remarks upon the nature of iron considered simply with relation to its adaptation for the entire construction of the hulls of Sea-going Vessels. The grand experiment of the practicability of this has been sufficiently and satisfactorily tried, by the recent arrival from England of three large Steamers built wholly of iron, but questions of great moment respecting the integrity (for want of a better term) of this metal when exposed to the chemical action of air or water, and also concerning the evils that are occasioned by the facility with which several kinds of marine animals appear to attach themselves to its surface, still occupy the attention of many very able naturalists, with the view of determin-

ing the extent of the former, and of preventing as much as possible the latter of these two great objections to the general employment of iron as a material for the purpose of Naval Architecture.

My appointment as Surgeon to the *Phlegethon*, one of the Steam Boats above alluded to, enabled me to make some observations upon the subject, not perhaps of any great value, but such as they are, I respectfully communicate them, with one or two suggestions resulting therefrom, which have at least this recommendation of being approved by Captain Cleaveland himself, particularly interested in the enquiry.

Knowing, however, that the Indian Government, with its usual energy and desire for the public good, has already instituted an investigation of the properties of iron, conducted by some of the most scientific men in Calcutta, I enter the discussion with diffidence, especially, as perhaps my views and recommendations upon the subject may differ very considerably from theirs, the result of long-conducted, and of course very accurate experiments. Scholastic leisure too, as it admits of an intimate knowledge with the whole circle of the sciences, or in lieu of that, of an immediate reference to the best authorities, is an advantage I have not possessed; but as an equivalent, and an apology also for intruding my remarks, I offer a constant residence and continual experience for above 18 months on board Iron Vessels, where opportunity was daily afforded me of observing and recording those facts, I conceived to be best suited for the determination of questions such as are now before us.

In the first place I have been led to believe, that the corrosion or oxydization of iron by sea-water is far from being an evil of that magnitude which it has been assumed to be; and in fact, I consider it to be the natural and only certain remedy to prevent the accumulation of marine animals and their habitations upon the surface of the metal exposed to the sea, resembling in this respect the very useful protective influence of the sea-salts on copper sheathing upon wooden vessels against a similar evil.

As regards the definition of oxydization, which the proper consideration of our subject certainly requires, the progress of Chemistry as a popular science, renders it unnecessary for one to enter more fully into details, than merely observing, that by the operation of general law of

nature, called the attraction of affinity, metals and all kinds of simple matter are disposed to join and form compound bodies with other kinds of matter in their immediate neighbourhood, and even when thus combined, if placed under favoring circumstances, compound bodies will frequently dissolve spontaneously intimate and very close relations, to assume new and totally different combinations with other substances; the only explanations for which, in our present state of knowledge, is, that in such cases, the elementary bases of the compound bodies are said to have a greater affinity or pre-disposition to join with the latter, than their former co-constituents, thus the carbonate of soda is disintegrated, and the union dissolved between the carbonic acid and the alkali soda, if it be placed in juxta-position with tartaric acid, for which soda has a greater affinity than it has for the carbonic acid; but to proceed would be to write a chemical lecture, and I will therefore terminate this otherwise endless digression, and return to my subject, by observing, that it requires the presence of very particular circumstances to produce any metal in a purely native state. The general rule is, that they are extracted from the earth in the condition of pyrites or salts, that is, in combination with oxygen, or some one of the various mineral acids, and from these salts, by the process of fusion, the different metals are reduced to the pure or working state.

After all the labor, however, bestowed upon them, the general tendency of metals is to return to their original condition of compound salts, and more than all iron seems disposed to this chemical alteration of structure, deriving readily from air, earth, and water, the necessary co-constituent oxygen, whilst fire only increases the intensity of attractive affinity, and thus accelerates the operation, so that all surrounding nature seems opposed to its remaining long in that metallic state which renders it at all useful or profitable; and as iron is daily becoming more and more employed for the purposes of mankind, it is an object of considerable moment to lessen as much as possible the vast expense, occasioned by the continually required replacement of the corroded or oxydized metal.

This, it is found, can be easily accomplished by opposing one law of nature to another, or in other words, antagonizing chemical affinity on the one hand, by electro-galvanism on the other, the best demonstrable proof of which operation is the well-known suspension of chemical

corrosion upon iron or copper when protected by contact with zinc; but here also I must be permitted to remark, that our best Chemists are altogether in the dark as regards a knowledge of the nature of these two powerful agents in the economy of the universe; we perceive their effects, and theorise upon their probable mode of acting, but nothing satisfactory or conclusive has yet been proved, except that we see the exercise of their opposite actions in the result of the protected metals before-mentioned, and are convinced, that analogy alone must direct us at present, in any attempts to extend our knowledge of the application of the anti-corrosive property of electro-galvanism, to useful and beneficial purposes.

But will the application of this principle or property of electro-galvanism be useful in the construction of iron ships; that is to say, will the protection from oxydization thus afforded to the hulls, be equivalent as a benefit obtained, to an evil which will certainly be consequent upon non-oxydization, namely, the accumulation of marine animals and their testaceous habitations upon the bottom of the vessel, and the same question may be also asked in cases where the iron is mechanically protected by thick layers of carbonaceous matter? I certainly think not; for independent of the retardation on the speed occasioned by the extensive surface, and sinuous character of the foreign bodies adhering, the necessity of every three or four months placing the vessel upon shore for the purpose of removing them from her bottom, must materially injure and strain her hull, besides the chances on such occasions in unknown parts, of her bed being of a rocky character, which would hazard at once her total loss, by the extensive injury she must sustain with her whole weight supported only upon points of rocks.

Let us, on the contrary, suppose, that an iron vessel starts for sea completely unprotected, the naked metallic surface of the iron fully exposed to the action of the water, we could anticipate no other consequence would result after a voyage of a few months, than perhaps a slight oxydization along the line of immersion, (owing to the combined action in that situation of air and water,) whilst the remainder of her bottom would be found to be clean, neither acted upon chemically by oxydization, nor affording the least harbour for those masses of barnacles, pedunculate or sessile, which, in the other case, experience has

proved would be the result. In fact such a vessel's bottom might be expected to present an appearance similar to that which an iron cable would do after a ship has continued at anchor some months, shewing evidences of corrosion only around the point immediately in contact with the surface of the water.

An opportunity of observing this difference in the condition of protected and unprotected iron placed in the same situation, and under the same circumstances, was afforded me whilst Surgeon of the *Pluto* Iron Steamer, which during a stay of nearly five months (repairing) in a small port in the south of Portugal, never raised her mooring anchors. It was found upon our departure, that an accumulation of testaceous animals, at least one inch in thickness, had taken place upon her bottom, covered or protected, as it was termed, with a coating of red lead paint, and afterwards with several layers of coal-tar, whilst the naked iron cables exposed to exactly the same aqueous influences, came up as clean as upon the day of our first anchoring.

Many experiments have also been made to prove this fact, that iron perfectly cleaned, will remain many months entirely submersed in water, without the least change being observed upon its surface.

I would also observe, that even the oxydization along the line of immersion, where it is exposed to the united action of the atmosphere and the water, is of such a character, as to afford no point for the adhesion of marine animals, for forming in small scales, easily detached, the attrition of the passing water is sufficient to remove them, and also the embryo attachments of such animal life that may have been deposited upon their surface.

It is curious to observe, how theory has in the case of iron-built ships, occasioned attention to be directed to an action in one situation and determined it to be an evil, while in reality it is most beneficial, and caused to be overlooked entirely the same action in another situation, where the corrosive influence exerts uncontrouled its fullest power, namely, in the hold of the vessel, upon the internal surface of the iron. Here, where there is always an accumulation of water to a certain extent, oxydization finds every circumstance favorable for operation—an increased temperature, water, both fluid and in a state of vapour, and a continued wash from the rolling of the vessel, which removing the newly-formed scales of oxydized metal, leaves again the naked

iron exposed to fresh attacks from the combined action of air and water. As surely and as rapidly as are the iron tanks for containing fresh water in men of war rendered useless by a similar operation, so will the hulls of iron vessels be corroded and destroyed, whilst the same mechanical means of protection which externally acts injuriously, forming a bed favorable for the attachment of marine vermin, would, applied internally, be the very best remedy that could be devised for preventing the extensive oxydization of the iron in this situation. I allude of course to the layers of coal tar, or otherwise bituminous compounds with which it is usual at present to overlay the bottoms of iron vessels.

As general opinion, however, appears to be in favor of some external covering for the iron, I know of none better suited to the purpose, than a medicated application long in use among the Persians and Arabs to protect the bottoms of their dows and other vessels from the adhesion, and consequent depredations of marine animals, and which appears to owe its protective power to the character of its principal ingredient — aloes, which either from its bitterness, or being a positive poison to such animals, completely prevents their adhesion; and as this in the case of iron vessels is a desideratum, a trial of it might be made, for I see no reason why the application should not operate equally beneficial in the one case as the other. The formula for its preparation, according to a recent publication under the head "Aloes," is as follows: One ounce of aloes mixed with turpentine, tallow and white lead, is sufficient for covering two feet, and it requires about twelve pounds for a vessel of fifty tons burden. As a simple modification of this, I should recommend, that to the common red lead paint usually applied to the bottoms of iron vessels, such a quantity of aloes be added, as to make it correspond as nearly as possible with the composition used by the Arabs. One hundred weight of aloes, would be about sufficient for a vessel of 500 tons burden.

With respect to iron tanks for containing fresh water, here perhaps the electro-galvanic influence might be beneficially employed, although one probable result might be the putrefaction of the water, which in common unprotected tanks, remains for a considerable length of time both sweet and wholesome. Its admixture with the very visible particles of detached oxide of iron, is the only thing complained of by the sailors, but as this is in some measure conducive to their health, a

remedy on this account only is unnecessary, but as a means of lessening ship's expenses with respect to the replacement of iron tanks, which I believe in five years' use are completely worn out, perhaps the anti-corrosive agency of electro-galvanism might in this case be advantageously tried.

The accumulation of the oxide of iron in the water of the tanks after a long voyage, is certainly excessive; and to obviate this inconvenience, I would suggest, that a large filter, of simple construction, should be placed forward for the use of the crew; to be made of wood in the form of a large box, three feet high, with a breadth from side to side of three feet; and from before, backwards, one foot and a half should be divided into two compartments by a central division, which should be perforated with a number of small holes to the height of the nine inches from its lower edge, so as to admit of a free passage for water from one compartment to the other. At the bottom of one of these compartments, must be placed layers of sand to a corresponding height with that of the small holes in the division, or nine inches, gradually changing the character of the sand upwards, from fine beach to rough coarse shingle. Let the water to be filtered be poured over this sand, which it immediately percolates, rising on the other side to an equal height, according to a well-known law of Hydraulics, perfectly clear and pure, partaking of all the characters of the best spring water. Thus simply can be procured a daily supply of clean draught water, sufficient for the use of sixty or seventy men. I scarcely need add, that the box would be rendered more water-tight, were it to be lined either with zinc or lead. A small filter upon this principle, but made of slate by Sterling of London, we had on board the *Pluto* and the *Phlegethon*, and its simple construction and efficiency were frequently the subject of remark and admiration.

As regards iron tanks again, although I do not myself see any great necessity for affording them the protection of electro-galvanism, except to prevent expense, still it would be satisfactory I think to the profession at large, if the following experiment were permitted to be made on a vessel proceeding to sea. It would consist of nothing more than observing the condition of the water contained in two separate tanks, one of which should be brought under the influence of electro-galvanism by being placed in contact with zinc, whilst the other should be in the usual unprotected state. The Captain or

Surgeon might be instructed to report, after a certain interval of time, upon the condition of the tanks, and the comparative amount of the oxide of iron found in each, also as to the state of the water they respectively contained, whether pure and wholesome, or otherwise; and as the result of the whole, which of the two tanks they recommend as best calculated for the storing of water.

These remarks have been thrown together under circumstances particularly unfavorable, for from a very painful abscess forming subsequently to an attack of fever, the greater part of the rough draught of this letter has been drawn up in bed, whilst this copy has been written in great pain; this must be my apology for the very desultory and very hurried character of my communication, which I was anxious should be forwarded to you previously to the docking of the *Proserpine*, which I have been given to understand will take place in a few days, and which will afford a favorable opportunity for experimental trial, and of forming a fair comparison between her condition and that of the *Phlegethon*, after they have been a few months at sea, should any of the suggestions contained in this letter be acted upon in the refit of the *Proserpine*.

Should you consider these observations to be either presumptuous or intrusive, I am sorry for having occupied so much of your time in such a manner, but ask your excuse upon this ground, that they have been dictated solely by a desire to promote, as far as lay in my power, the interest of my country, both political and commercial, in this quarter of the globe. But not to detain you longer, with every respect, I am,

Howrah, July 12, 1841. Dear Sir, &c.

(Signed) Charles Johnson.

(True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

Fort William, Marine Superintendent's Office, the 23*d Sept.* 1843.

No. 1156 of 1841.

Superintendent's Office, Bombay, 24*th July,* 1841.

Sir,—In compliance with your request, I have the honor to state, that as yet experience on the durability of Iron Vessels exposed to Sea-water in Bombay, does not afford sufficient data for judging of the probable durability in comparison with the same material on the Ganges.

2nd. There is reason to believe the corrosive power of Sea-water varies in different localities of this Harbour and the Red Sea; it appears to be far greater than in the intermediate ocean, while on the Western Coast of South Africa, it far exceeds either. The corrosion sustained by the "*Berenice's*" paddle-wheels, during the short time she was off the Cape of Good Hope, was apparently greater in extent than during the whole time she has since been in India, and the Iron Boat taken out to the Niger by Mr. Laird, is said to have suffered much from corrosion. In the Red Sea a small description of barnacle forms on iron, beneath which corrosion is very rapid, destroying the outer coat of the metal; it becomes honey-combed, the same effect in a degree in Bombay Harbour also, a weed grows upon it, destroying any paint or varnish with which it may be coated; the best preservative has been found in a composition of red lead and linseed oil; but for Steam Vessels' bottoms, mineral pitch and rosin melted in spirits of turpentine.

3rd. It may be worthy of remark, that the "*Hugh Lindsay*" has still the identical paddle-arm segments she started with in 1829.

4th. Time has not yet been given to form any very correct data of the durability of the Iron Boats, and in any opinion founded on analogy with the paddle-wheels of Sea-going Steam Vessels, various elements which we are as yet little acquainted with, must be taken into account. Thus the galvanic action of a stream of water passing along the copper, has been known to cut through heavy paddle-beam stays in an incredible short time, as also the arm and segments; the quality of the iron may have an influence, as also the smoothness of surface in the plates composing the bottom of an Iron Vessel.

5th. Mooring chains are observed to be perfectly sound when laying in the mud, partially corroded when suspended, but very soon destroyed near the surface and in contact with the copper.

6th. Time and observation can alone throw light upon this little-understood and interesting theory. I have, &c.

(Signed) R. Oliver, *Capt. R. N.*

To C. B. Greenlaw, Esq. *Secretary Marine Board, Calcutta.*

(True Copy.)

(Signed) C. B. Greenlaw, *Secretary.*

Fort William, Marine Superintendent's Office, the 23d September, 1843.

Notes on, and a short Vocabulary of, the Hinduvee Dialect of Bundelkhand. By Major R. Leech, c. b. *Political Agent. From the Political Secretariat of the Government of India.*

The Notes and Vocabulary were collected in the course of a five months' residence at Punna.

The Banphara dialect differs from that now to be treated of. The latter is a mixture of corrupt Sanscrit, and perverted Persian ; a kind of slurred and slovenly Oordoo.

The first peculiarity that strikes a stranger, is the substitution, at the end of words, of *o* instead of the Oordoo *á* ; as, hamáro, instead of hamárá. It is sometimes substituted for other vowels in the middle of words ; as, moro, instead of merá. Another peculiarity, is, the substitution of *r*, and *n*, for the Oordoo *l* ; as, mooree, for mulee ; and nakareeyá, for lakree ; and, sometimes, vice versa ; as, leelo, for neelo. The Oordoo *the* is slovenly pronounced *te*.

The diminutives, or derogatives, of substantives are very generally used ; as ghurwá as well as ghorá ; tateewá as well as tatoo.

Of the Alphabet and Character.

The character is based on the Devanagree. The Sanscrit vowels ऋ ॠ ऌ ॡ are unknown.

The kh is written ष, and not ख, while the real ष gh is not known.

The gh is written घ, and differs only from the घ dh by having the cross stroke.

The Sanscrit ङ ञ and ण are unknown.

The b व differs from the w व् only by a dot below ; and the p प differs from the y प् only in the same manner.

The Sanscrit य y is not known as a consonant, except in a compound letter ; its place being supplied by j, which is also substituted for z. The Sanscrit श् is unknown ; its place being supplied by simples. In the same manner the Sanscrit kgh क्ष is supplied by chh.

The Sanscrit ए e has two pronunciations : one, as *a* in mane, cane, &c. ; the other, which I have expressed by ae, has the sound of *a* in

mare, care. The *o* has also two: as, *o* in cone; and *o* in bore, or *oa* in hoar.

I have distinguished the soft and hard letters, as follows:—

त t थ th द d ध dh

ट t ठ th ड d ढ dh

and the harsh ड़ I have expressed generally by ḍ, and not by ṛ following the Devanagree ड़, and not the Oordoo ڑ ṛ.

The Hinduvee character of Bundelkhand is written most correctly by the tribe of Káiths. The Banyans, in writing it, leave out all the vowels.

The Oordoo *w* is often changed into *b*; as, be for we (they).

The nasal · dot (sun) I have expressed by *n*.

अ I have expressed by a; and आ by á.

ि by i, and ी by ee; ु by u, and ू by oo.

Gender.

A noun is made feminine from masculine, as follows: betá, bitiyá; ghorá, ghuriyá; a female speaking uses *ee* instead of *o* in the termination of the first person.

Number.

The plural number is formed from the singular, as follows:—

ghoro,	ghore.
pátee,	páteen.
kutiyá,	kutiyán.

Case.

The inflected case, ready for receiving the addition of the post positions, is formed as follows:—

Singular.	*Plural.*
ghoro,	ghore.
ghore,	ghoran.

PRONOUNS.

Singular.	*Plural.*
mae, I	ham.
mo, inflected case,	ham (hawá.)

tae, thou	tum.
to, inflected case,	tum.
ae, this	ae.
in, inflected case,	in.

---

oo, that	oo.
oo, inflected case,	oon.

---

apun, self
apun, inflected case.

---

ko, who
kee, inflected case.

---

ká, what
káe, inflected case.

The Cardinal numbers that differ from the Oordoo, are:—

16	sorá,	51	inkyáwan.
38	aḍtees,	54	chouwạn.
44	chawálees,	57	santáwan.
46	cha,álees,	58	authâwan.
49	unanchás,	67	sarsath.
68	arsath,	93	terânawe.
83	terasee,	97	santânawe.
89	nouwásee,	98	antânawe.
91	inkyânawe,	99	ninyânawe.

In like manner the following are the Ordinal numbers:—

5th	pânchanw,	8th	atanw.
6th	chhatanw,	9th	namanw.
7th	satanw,	10th	dasanw.

Fractions.

¼ páw. ½ ádho. ⅓ tihấo.

Names of the Months.

Chait, sunwat 1900,	commenced or will commence		in 1843	on 14th Mar.
Baisáck,	,,	,,	,,	12th April.
Jeth,	,,	,,	,,	12th May.
Asád,	,,	,,	,,	11th June
Sáwan,	,,	,,	,,	11th July.
Bhádo,	,,	,,	,,	10th Augt.
Koohâr,	,,	,,	,,	9th Sept.
Kátik,	,,	,,	,,	9th Oct.
Aghan,	,,	,,	,,	8th Nov.
Poos,	,,	,,	,,	8th Dec.
Máh,	,,	,,	,,	13th Jan.
Phágan,	,,	,,	,,	12th Feb.

Lond, the 13th intercalary month every 3d year.

Days of the Month.

parmá,	1st (after full moon,)	8th	áthe.
doj,	2d	9th	name.
teej,	3d	10th	dase.
choth,	4th	11th	eka dasee.
pánche,	5th	12th	duá dasee.
chhat,	6th	13th	teras.
sáte,	7th	14th	chondas.
15th	Amáwas,	30th	Poone.

From 1st to 15th, is termed badee or lagat.

From 15th to 30th, is termed sudee or utarat.

Jeth badee áthee Samvat, 1900 } 20th May, 1843.

CONJUGATION OF AUXILIARY VERBS.

Indicative Mood.

Present Tense.

mae ánw,	ham hae.
tae á, i,	tum ho.
oo á, i,	be hae.

Perfect Past Tense.

mae hato,	ham hate.
tae hato,	tum hate.
oo hato,	be hate.

Imperfect Past Tense.

mae hot to,	ham hot te.
tae hot to,	tum hot te.
oo hot to,	be hot te.

Pluperfect Past Tense.

mae bhoa to,	ham bhai,e te.
tae bhoa to,	tum bhai,e te.
oo bhoa to,	be bhai,e te.

Future Tense.

mae hoohon,	ham hoonhe.
tae hoohae,	tum hoonho.
oo hoohae,	be hoonhe.

IMPERATIVE MOOD.

tae ho,	tum how.

SUBJUNCTIVE MOOD.

(Kaját, if Perfect Past Tense.)

mae hoto,	ham hote.
tae hoto,	tum hote.
oo hoto,	be hote.

Verbal noun.	hubainyá.
Infinitive.	hobo.

CONJUGATION OF THE VERB *Khaḅo*, to tell.

Present Tense.

mae kahat,	ham kahat.
tae kahat,	tum kahat.
oo kahat,	be kahat.

Perfect Past Tense.

máene kahee,	ham ne kahee.
taene kahee,	tum ne kahee.
oone kahee,	un ne kahee.

Imperfect Past Tense.

mae kahat hato,	ham kahat hate.
tae kahat hato,	tum kahat hate.
oo kahat hato,	be kahat hate.

Pluperfect Past Tense.

maene kahee hatee,	ham ne kahee hatee.
taene kahee hatee,	tum ne kahee hatee.
oone kahee hatee,	un ne kahee hatee.

Future Tense.

mae kenhon,	ham kenhen.
tae kenhe,	tum kenho.
oo kenhe,	be kenhen.

Imperative Mood.

tae kon,	tum kaho.

Subjunctive Mood.

Present Tense.

mae kahon,	ham kahen.
tae kahe,	tum kaho.
oo kahe,	be kahen.

Perfect Past Tense.

mae kahto,	ham kahte.
tae kahto,	tum kahte.
oo kahto,	be kahte.

Verbal Noun. kahainyá.

Adverbs, Past and Prepositions, Conjunctions, &c. &c.

oonche, oopar,	above,	bheetar,	in.
		báhar,	without.
khále, taren,	below.	adhpar,	in the middle.
		ite,	here.

ute, there.
ee kaná een, on this side.
oo kaná een, on that side.
dahne, to the right.
deren, to the left.
sáme, in front.
páchhe, behind.
jaldee, quickly.
haren, slowly.
lo, up to, till.
ko, kee, of.
kon, to.
se, from.
parant, but.
kabe, when?
jabe, when.
tabe, then.
ákasmát, suddenly.
áj, to-day.
kál, yesterday.
bhyáne, to-morrow.
paron, day after.
naron, day after that.
lánen, for.
saetmaet, gratis.
nit nit, daily.
murak, phir, again.
ánge, formerly.
abe, now.
azpher, gerger, roundabout.
hou, yes.
anhán, no.
bigar, without.
chánhen, or.
káe, what is it?

deelan, in person
engar, nere, near.
pe, on.
sánmoo, muhran, in front.
sadámat, always,
gujárath, by the hands of.
hoke, viâ.
dheer se, slowly.
bilát, much.
kabon, ever.
tanak, a little.
dárak, sometimes.
baryánee, violently.
babut oo, much indeed.
pahle gi ude, on the other side.
aele gi ude, on this side.
nirá, kewal, nirbak, entirely.
agen, before,
páchhe, after.
se, than.
kaját, if.
athae, in the evening.
darobast, altogether.
bánokee, quickly.
kanáee, on the part of.
Rám dhuwai ee, by Ram, for Ram's sake.
Thákur sonh, by God (patron or local saint.)
woa, and.
sakáro, early in the day.

List of Verbs that differ from the Oordoo.

ringbo, to proceed.
ábo, to come.
jebo, to go.
terbo, to call.
batebo, to speak.
lukabo, to hide.
mádbo, to knead.
leábo, to bring.
rákhabo, to put.
uthbo, to rise.
banábo, to cook.
todbo, to break.
khujábo, to scratch.
batebo, to speak.
ench lebo, to abstract.
oll devo, to imprison.
bán lebo, to take a hand or wrist (protection.)
hat karbo, to insist on.
gamm / khebo, to wait.
cheenbo, to recognise.
dheer dharbo, / monge rahbo, to be silent.
usebo, to boil.
baebo, to sow.
udelbo, to pour.
kapabo, to tremble.
ripatabo, to slip.
rupabo, to wait.
jánbo, to understand.
le jebo, to carry away.
uthábo, to raise.
baithbo, to sit.
márbo, to beat.
bhoojbo, to roast.
udhelabo, to pour.
chedbo, to prevent.
lámbandebo, to concentrate a force.
chhoochhee toofak ghálbo, to fire blank ammunition.
band karbo, to prevent.
latak jebo, to return.
galá phásbo, / garsentee debo, to hang one-self.
lab debo, / bálá debo, to make specious promises.
khebo, to ply a boat.
khaebo, to eat.
páta debo, / niptádebo, to finish, settle.
talab karbo, to demand imperatively.
bitarbo, to distribute.
peecho ho jebo, / pás jebo, to die.
leelbo, gutakabo, to swallow.
disá hobo, / farákat hobo, to ease one-self.
matyábo, to rub earth on the hands previous to washing.
karoola karbo, to rinse the mouth.
kalebá karbo, to breakfast.
pharbo, to bear fruit.
simit rahbo, to contract from fear.

Vocabulary of Nouns.

halko,	light.	nennoo,	butter.
garaw,	heavy.	goras,	(cow-juice) milk.
buro,	bad.	mathá,	butter-milk.
achho, nono,	good.	hadiyá,	cooking pot.
patro,	thin.	páro,	cover.
motho,	fat.	sil,	mortar.
pakko, neechat,	strong.	ludiyá,	pestle.
		karaiyá,	tin.
bejár,	ill.	seeso,	lead.
bado,	large.	peetar,	brass.
choto,	small.	lodee,	soft part of the ear.
lamon,	long.	tarwa,	sole.
chonro,	broad.	piduree,	calf.
peda,	tree.	ghoote,	knee.
bitiyá,	girl.	kurchee,	ancle.
ágee,	fire.	táree,	palm.
purwá,	a hamlet.	teonee,	elbow.
chonharo,	a rat.	kabjs,	arm, above elbow.
sánp,	a snake.	kandhá,	shoulder.
parrwá,	pigeon.	ghitkee,	windpipe.
batero,	quail.	dádee,	chin.
bighana,	wolf.	bironee,	eye-lash.
náhar,	tiger.	tope,	eye-lid.
tiduá,	leopard.	pág,	turban.
sreeghos,	panther.	konro,	soft.
ker,	plantain.	karro,	hard.
gádar,	sheep.	sonsar,	smooth.
medo,	a ram.	bheenjo,	wet.
gaiyán,	cow.	bár,	hair.
bael,	bullock.	kakwá,	locks of hair.
jawá,	barley.	choondaiyá,	top-knot of hair.
dastá,	pewter.	kankaree,	arm-pit.
kháud,	sugar.	kwámee,	virgin.
cheenee,	soft sugar.	ráud,	widow.
nakareeyá-káth,	wood.	muns,	husband.
		litár,	forehead.

káro,	black.
leelo,	blue.
hareero,	green.
chandá, chandrmá,	moon.
tarainyá,	star.
baehar.	wind.
bagroodo,	dust-storm.
ujyáro,	light.
gehro,	deep.
borá,	dumb.
bihro,	deaf.
loolo,	lame with both legs.
kanwán,	blind of one eye.
cháro,	grass.
sufet,	white.
ánand,	pleasure.
pirát,	pain.
kuwá,	well.
gael,	road.
palechá,	saddle.
páero,	stirrup.
mohrá,	headstall.
har,	plough.
jooná,	yoke.
kudáree,	pick-axe.
haseeyá,	sickle.
toriyá,	hillock.
bakalá,	bark.
dár.	branch.
soodho,	straight.
ondo,	upset.
irádah,	corruption of ilákah.
saksee,	ditto of sa*kh*tee.
kissah,	quarrel.
sahsá	injustice, mistake.
kumak,	anger.
lapká, laparhá,	active.
sarick,	enemy.
khuns,	anger.
allball,	shuffling.
káchee,	a gardener.
dheemar,	a bearer.
káith,	Hinduvee writer.
bádar,	cloud.
chipee,	a tailor.
ladiyá,	mason.
hiráno,	stray (animal.)
aber, kubera,	delay.
chaprá,	sealing wax.
pátee,	note.
badalo,	answer to letter.
sikhápan,	instructions.
bideewár,	stating particulars.
lág,	provisions.
milak,	black mail.
giláwo (khaban,)	mud.
seho,	waterfall.
soondo,	island.
dáng,	jungle.
lugye,	woman, wife.
sáre,	brother-in-law.
dukará,	old man.
dukariyá,	old woman.
sasurár,	village of father-in-law.
mamyáro,	ditto of maternal uncle.
samdhyáno,	ditto of son's father-in-law.
máiko,	village of married woman's mother.
bikat,	difficult.
moorá, mooree,	reddish.

judhaiyá, moonshine.
nyáo, quarrel.
thanwár, horse-keeper.
baredee, cow-herd.
cheree, chiriyá, goat.
gadariya, shepherd.
pardanee, man's dhotee.
pidee (méchee), chair.
ghám, sunshine.
lapat, hot wind.
gagrá, earthen pitcher.
nád, earthen tub.
likhaiyá, writer.
jhanjiree, lattice work.
nattet, relation.
nátedár, ristedár, relation.
adá, place of dwelling, refuge.
kamtána, work, building.
eek deel, one person.
deelan, in person,
badkáo, conversation.
maksad, consultation.
purt, secret.
dát, key to plunder.
dugaiee, verandah.
lábree, falsehood.
chhán, tadárak, enquiry, justice.
bakree, walled dwelling.
nonee, kháso, good.
sáha, honest man.
baramná, anxiety.
penkará, fetters.

siyánee, grown up(daughter.)
jablo, former.
bintee, petition.
sujas, fame,
newto, congratulation, a guest.
Choumás, 4 months, rainy season.
bhánware, the day on which the bride is handed over to the bridegroom.
oognee, ágonee, the day on which the Barát arrives.
Barát bridegroom's party.
khadán, mine of diamonds.
marwá, first day of marriage ceremonies.
náoo, a barber.
náw, name?
nánw, a boat.
dondá, a cause.
sároo, each of two men who have married sister's is to the other.
bahu, son's wife.
damád, daughter's husband.
jet, husband's brother (elder.)
dewur, ditto ditto (younger)
nand, ditto sister (older.)
bábájoo, ditto father.
bhabhájoo, ditto mother.
baiyah, — sister (younger.)
baijoo, ditto elder sister.
Parwá, small village.
k,hero, few huts.

gánw, village.
sahar, town.
náro, nullah (rivulet.)
báj k,hyee, suddenly happened.
jeto, elder brother.
majhlo, 2d ditto.
sajhlo, 3d ditto.
lohro, younger ditto.
kaká, peetee, father's brother.
phuwá, father's sister.
ajá, father's father.
ájee, father's mother.
mámá, mother's brother.
mosee, mother's sister.
naná, mother's father.
nánee. mother's mother.
saráj, wife's sister (elder.)
sáree, ditto (younger.)
bhateejo, brother's son.
bhánej, sister's son.
ditto daughter.
bhyee, (brother) kaká's son.
phuwá's ditto.
mámá's ditto.
mosee's ditto.
jareenámah, mámlo, dáur, fine.
bast, thing, article.
k,haleetá, pocket.
bhojye, brother's wife.
karro, stiff.
kajureeá, young wheat grown in pots and thrown into the tank on the last day of Sáwan.
patureeá, musulman concubine.
pero, a tree.
houldir, sirree, behá, págil, mad, crazy.
mánas, manukh, man.
behuro, creditor who lends money.
tihaiee, ⅓ instalment of revenue, sáwan, aghan, chait.
khojnámah, search.
pattá, trace (of marauders.)
bheer, force, party of armed men.
ján chinár, acquaintance.
lekhá, writing, accounts.
tál, rank.
athye, assembly of villagers in consultation.
medo, boundary (near.)
dot, inkstand.
jurdán, writing materials.
rabáb, rawye, custom.
Thakuriyá, a thákur,
dánkoo, a marauder.
rakhoee, levying troops. [lands.
punyárthee, the enjoyer of charity
Bamanye, matricide, suicide, &c. committed by a bramin, &c. in supposed self-defence.
táns, reprimand.

sanad,	ready.	dándas	oppression.
diwáro,	door.	chutkee,	a note.
mood,	head.	kháṁ,	envelope.
thar,	head (of cattle.)	lakhotá,	wafer or gum which closes a letter.
pandá,	a cook.		
padiyá,	young buffaloe.	teeto,	damp.
usareeyá,	a little larger one.	khaprá,	a title.
báro,	a child.	tál, talaiyá,	tank.
dor,	cattle.		
prasang,	conversation.	cheep,	slate.
gujárath,	by hands of.	dundee,	marauding.
Prohit,	family priest, (a bramin.)	dundet,	marauder.
		setee,	whistling.
kewat,	boatmen.	bekh,	dress.
hád,	boundary (far.)	machree,	fish.
bukra,	a tax fixed, and half levied, by the chief in whose territory a widow (of all but the four principal castes) first married from the man who intends to keep her.	badmásee,	disturbance of peace.
		banjee,	a banyan's traps hawking about.
		bhowree,	circuit for hawking or intelligence.
		thát,	a chief's herd.
		bagar,	a villager's ditto.
		nár rahá,un,	combined village herds.
Pichorá,	ditto, ½ ditto where born ditto—N. B. The chief does not give the widow without her consent, and she cannot give herself away without his consent.	altráeeso, Prithee ráj ráeeso (to Kanoje,) chatur purkás,	Histories relating to Bundelkand.
chakariyá,	(chákar), servant, a sepai seeking employment.	bagáre,	separated.
		narwá,	streamlet.
		jánabá,	acquainted.
sustye,	absence of suspicion, and care, unprepared	jhungee (ahijdee),	a tent.
átas,	fear, dread.	pát,	breadth of river.

chhurá, razor.
kathanee, scissors.
Patwáree, statistics of a village.
dujágee, having two masters.
barejo, a pán plantation
sádháran, easy.
katahar, fruit (jack.)
lathar, harsh.
chironjee, seeds of the achar fruit.
parora, a vegetable.
jakká, concern of mind.
dasee, a sign, proof.
swám dharmee, fidelity to one's master.
ásaro, dependence.
sapar, bathing.
douwá, title of an Aheer.
dháee, nurse.
dhouwá, ditto's husband, called by child dáoo.
Barwáree, title.
kakaroo, gravel in which diamonds are found.
jamokh, confronting.
nádar, dispraise.
khará, a hare.
laraiyá, jackal.
lukhareeyá, fox.
kul, plenty of.
sarak, high road.
kowwa, crow.
kuliyá, a lane.
diwálo, a temple.
teep, written promise to pay for indemnification from plunder.
dohá, ser, verses.
bilát, many (days.)
ojee, one man taking another's place.
sistácháree, flattery.
sánto, eatable.
gamm, ability.
phuskará, fawn.
bhuchch, a jungle man.
galee, a road.
párae, roe.
chikrá, deer.
les, trace.
madye, a man.
dokh, fault.
huzooranee, a concubine given to a dependent of the Rajah's, a cast off mistress.
Pardwár, a Hindoo mistress of a Rajah who lives in seclusion (purdah.)
huzooree, a servant to whom a cast off mistress is given to keep.
Horee, the Holee festival.
Budhwá mangal, the Tuesday after the Holee.
panainyán, shoes.
mihpar, honey.
maen, wax.
máchho, honey-bee.
machhee. ditto smaller, fly.
kontiyo, ditto still smaller.
sawád, caste.
teelee, the milk of a she-buffaloe just thrown a young one before it has sucked.

kheer,	rice first browned and then boiled in milk.
chhimá,	silently.
ditto karo,	hold your tongue.
kisee ke oopar marná,	to commit suicide on account of another's treatment.
kadero,	stick maker.
lenroo,	a coward.
nirá, kewal,	complete, entire.
rasoee,	a meal, food.
bardá,is,	provisions, earthern utensils, firewood, grass, pegs.
rasad,	ditto, atta, dal, &c.
kisán,	cultivator.
misal,	caste, connection.
padath,	custom of a caste.
upacheer, ucham,	disturbance.
deen band,	defender of the faith, (address to a superior.)
parwar,	a vegetable.
kundaroo,	ditto.
non,	salt.
najor,	weak.
kháro,	salt, (adj.)
karwo,	bitter.
khato,	sour.
meeto, gureero,	sweet. tasting of ghoor.
chirparo,	not pungent.
madheer,	greasy.
etáeelo,	astringent.
garist,	bloating, indigestible.
bharetoo,	a pair of animals.
byá,	weighman.
palledár,	a grain porter.
thapareeyá	a slap.
lateeya,	a walking-stick.
badaiee,	a carpenter.
kundero,	a turner.
lakhero,	worker in lac.
kachero,	worker in kách (glass.)
kunjaree,	fruiterer.
barchee,	a footman's spear, mark of a Bundela.
nuthehá,	confectioner.
bajáj,	cloth seller.
chik, khateek,	butcher.
báree,	torch-bearer.
halálceyá	a sweeper.
farás,	to the usual occupation adds that of camel man.
chatewree,	painter of figures.
baraiee,	pán-seller.
josee,	receiver of alms of religious feasts or fasts.
kagdeegir,	paper-maker.
nabdeegir,	pad-maker.
cháwar,	rice.
chonr,	chowree.
panchhee chetáwanee.	list of birds.
gahno chetáwanee.	list of jewels.
phool chetdwanee,	list of flowers.

cháro, fodder for horses, cows, and buffaloes.
gedá, ditto for elephants.
dálee, ditto for camels.
pattee, ditto for sheep.
beboocha, taken up with.
kaif, anger.
chun, bird's food.
ghane, crowded together.
panám, poor man's salute of a dhámee.
surág, tracing of thieves.
gonhoon, wheat.
duhaiee, rule, government.
dalidra, daridra, cares and troubles.
johukm, as order, answer to a superior's order.
satyánás, annihilation, ruination.
bipat, cares and troubles.
sáwkas, worldly means.
phaldan, the present sent by the father-in-law to his intended son-in-law, cocoanut, a rupee or mohur, &c.
sagaiee, first entertainment at the son-in-law's house.
lagun, the paper containing the appointed wedding days.
palechá, horse's pad.
gadee, elephant's pad.
jaháj, camel's pad wood.
palán, pad do.
bandhej, livelihood, means, arrangement.
koowa, a son.
daskhat, circumstance.
sarjant, arrangement.
dhepan. office of nurse.
dohrá, door.
angochha, handkerchief.
modlo, recrimination, reprisal.
duhai,ee, rule, government.
khawás, samáree, title of a barber.
ánhán, no!
tanak, little, least.
seedho, plain fare, wheat, ghee, salt and dal (rations.)
kanak, wheaten flour.
tanak, a small quantity.
surág, tracing of thieves.
larj kee bát, suspicious expressions.
jhuláhoolo, twilight.
thádho, standing.
kuchee, key.
táro, lock.
akrás, enmity.
badeeyá, bándá, crop-tailed horse.
bandá, raised place to hold wheat.
khondeeyá, sunk place to hold wheat.
bár, hair of men.
bár, hair of animal.
bár, wool.
noh, nail of finger or toe.
mekh, iron nail.
sum, hoof.
álas, inattention, laziness, yawning.

kus, a kind of grass.
luchaiee, a cake (pooree.)
hetee, a friend.
Be,uháree, an equal in society of a different caste.
barbast, fee for jageer.
bandej, preparations, arrangement.
barbas, oppression, extortion.
pooro, even.
oono, odd.
swáhá, amen, empty, echo of another's sentiments.
chunduwá, bald-headed.
basor, basket-maker.
bákhar. enclosed dwelling.
kachwáro, kitchen garden.
bheda, bhendee, } vegetable.
boṭh, swell of river.
pasopes, indecision.
oot patank, wild schemes or sayings.
mahago, dear.
sasto, cheap.
bardán, blessing, favor.
seeng, horn of animal.
sáwdhán, intelligent.
amasee, mixed (Ban) amez.
toonká, chip.
Banduwá, a prisoner.
ghái̇l, wounded.
wafic, conversant.
sahná, revenue collector for village.
mukálabo, confronture.
salákhán, ruler.
bichlee, routed, dispersed.
sustye, confidence, absence of apprehension, tranquillity.
sudhár, advantage, benefit.
choakhtá, enclosure, gate.
hirmijee, cochineal colored (kirmizee, Persian.)
pahoonaee, guest for some time.
byáree, dinner after sunset.
dataon, vegetable tooth-brush.
kariyá, black complexion.
sávroa, dark do.
goahoowá Ḃaran, } wheat colored ditto.
goroa, fair ditto.
bhoorá, white, European ditto. (leper-like.)
bhatá, tomatus.
khámeendá, authentic, competent, (authority).
bát, award, a sentence.
tapurs, entrusted.
daskat, syllable,hand-writing.
bihee, guava.
pachhyáur, curds sweetened with goor.
sádee, cream.
behar, a well with steps.
báree, garden ground enclosed with thorns.
chitáse, spotted.
thor, head-piece.
ato, hindrance, draw-back want of completion.
dámar, a continued thick jungle.

thakuráin,	wife of a thakoor.	baráee, ookh,	sugar cane.
áns,	"tuhmat."	gulcháh,	false rumour.
kujas,	ill fame.	bhatiyá,	hillock.
kunnas, mujrá,	salutation, (low).	samaetá,	assembly.
moos,	loan.	galgal nimuwá.	lemon.
gael,	a road.		
unsár,	inkling.	beuhár,	return wedding present.
tipariyá,	basket.		
madeee,	"mendee."	phaká,	piece of any thing divided.
khobá,	milk boiled to a thickness.	pisán,	flour of any kind.
oatbo,	to fry milk to a consistency.	beero,	brother.
		phar,	fruit.
jaraeta,	thorns.	sadáwart,	permanent alm's fund.
boal,	a runner, creeper.		

N. B.—Few or none of the words have been entered that were not first actually heard in conversation

The Vocabulary could of course be added to, by those who have had the advantage of a longer residence than I had in Bundelcund.

Logan ke nárdáns mens surwáran ko bede á,o,	Conceal the swords in the people's gutters and return.
Parná kee khabar ko kachhu bhádo naee,	There is no dependence on the Punna news.
Ham athai ka bhanhan,	I will eat this evening.
Rotee bhát hai,	He is eating bread.
Kadáchit sarkár ho mánas Jeitpoor wáran ke háth á jenhen to be már dáshen,	Would the Jeitpoor man kill a government servant were he to fall into his hands?
Ko Thákur hai,	What caste are you.
Rájá kee bhet to nahoohen,	You may not have seen the Raja.
Hamáro nará Lodee men gado hai,	Lowri is the place I (literally my naod) sprung from.
Ute rehabo kare,	Continue to remain there.

Ambalah, 31*st December*, 1843.

A note on the Winds, as influencing the Tracks sailed by Bermuda Vessels; and on the advantage which may be derived from sailing on Curved Courses when meeting with Revolving Winds. By Lieut. Col. Reid, *Governor of Bermuda.*

It may at first sight appear, that we in India have little to do with "the Tracks sailed by Bermuda Vessels;" but further consideration will shew to those who have paid attention to this subject, that not only as a general question of science, and a new and beautiful practical result of theory and research in this new branch of Meteorology, but also as being capable of extensive application in our own seas to the Eastward of the Cape, this paper merits the closest study: for it is much more than probable, that future research will shew us, that by an analogous system, the great storms of both Southern and Northern latitudes may all be used as means of shortening voyages by the simple rule of sailing, partly round their circumferences, or keeping in their favourable quadrants, instead of beating across or lying to in them, or pursuing tracks which lead into meeting with them "on their wrong sides," in the latitudes in which they prevail. We are indebted to Col. Reid for a copy of this valuable note.—H. P.

In high latitudes the atmospheric currents, when undisturbed, are westerly, particularly in the winter season. If storms and gales revolve by a fixed law, and we are able by studying these disturbing causes of the usual atmospheric currents, to distinguish revolving gales, it is likely that voyages may be shortened.

The indications of a revolving gale are, a descending barometer with a regularly veering wind.

From Bermuda to New York.

In a voyage from Bermuda to New York in the winter, strong westerly winds, together with the Gulf Stream, would carry vessels attempting to sail direct to New York, to the eastward of their course. No doubt all seamen are aware of this, and do in consequence make some allowance by keeping to the westward. But according to usual practice, on an east wind overtaking them, they would steer in a direct course for their destined port, making allowance only for the current, as the wind would be considered a fair one. If however the gale were a revolving one, the wind, at first easterly, would veer until it became westerly: and would probably blow from the westward with increased force, when the vessel would be carried off her course. It is therefore a subject deserving consideration whether advantage should not be taken of the temporary east wind in order to run to the westward nearly as far as the meridian of Cape Hatteras; so that in the rest of the voyage to New

York, the chance of reaching that port would be the same as that of coasting vessels in their voyage from the Carolinas.

But should a dry easterly wind set in, and the barometer maintain its mean height, or rise above it, the case would be altogether different; for these would be indications of a steady wind, and not of a revolving gale. The ship may then be steered direct for the intended port; and this shews that the hygrometer might prove a useful instrument at sea, though not hitherto used that I am aware of, in aid of navigation.

Since vessels sailing from Bermuda and bound to New York, or the Chesapeake, must necessarily cross the Gulf Stream, they will have an advantage in doing so before that stream begins to set strongly to the eastward. For this reason, as well as to have a better chance of getting to the westward, it would seem advisable on first leaving Bermuda, to make no *northing*, but if the wind should at the time blow, for example, from the north-west, to sail free upon the starboard tack, and to keep on this tack, until the vessel be so far advanced as to fall into the northerly current of the Gulf stream; and this might prove to be the best course to pursue, even should the ship for a time make *southing*. The more southerly the port to be gained, as for example, Baltimore, the more does it appear advisable that this should be persevered in. The same principle of sailing for Boston and even for Halifax, (though in a much less degree) might be found to be that by which the most certain course would be secured. It may appear unreasonable to propose, that a ship bound to a port to the *northward*, should on leaving Bermuda, steer *southerly*—yet when we shall be better acquainted with the causes of the variable winds, and their changes, this may really not appear to be so unreasonable.

For example, towards the end of a revolving gale passing over Bermuda, the wind may still be west, and blowing hard. Since the courses of such gales are northerly, a ship by steering north would only continue the longer in the same westerly gale, whereas by steering southerly, the ship and the storm would be moving in opposite directions, and the vessel would the sooner have the chance of falling into a new variation of the wind. Sailing southerly, on the starboard tack, the latter end of such revolving gales as the one supposed above, might (as frequently happens) veer to *west-north-west* and even to *north-west*,

which would enable a ship to come up and make a better course towards the west.

These suggestions are offered to practical seamen, in the hope that some persons will be induced to consider this subject; and if gales really revolve, that advantage may be taken of their mode of action.

From Barbados to Bermuda.

In sailing from the West Indies to Bermuda in the winter season, the trade wind will generally enable vessels to gain a meridian, sufficiently to the westward, before they leave the latitudes where it usually blows; and in winter, it would seem desirable to make the 68th or 70th degrees of west longitude, before leaving the 25th of latitude.

From Bermuda to Halifax.

In voyages between Bermuda and Halifax, in the winter season, the same reasons hold good for keeping to the westward, as have been recommended for the passage from the West Indies to Bermuda, but in a much greater degree; for in this latter case there is not the easterly trade wind to carry ships to the westward.—On the contrary, the west wind may blow throughout, whilst the Gulf Stream also would tend to set vessels to the eastward. The degree of westing to be made in this passage in the different seasons, does not seem to be agreed upon.

The chief object however of this note is to point out the benefit which may be derived from profiting from the east wind, which blows on the *polar* side of a revolving gale, before the wind shall veer to the westward.

From England to Bermuda.

On leaving England for Bermuda, instead of following the usual practice of steering straight for the destined port, on the setting in of an easterly wind, it deserves consideration whether ships should not sail *west;* and if the wind should veer from the east by the south, towards S.S.W., S.W., and West, whether they should not continue on the larboard tack, running free, until by changing, they could lie their course.

The wind after this might continue to veer towards the north, so that the ship might still come up, with her head to the westward of her direct course. On both tacks she would have sailed on *curved lines*, the object of which would be to carry her to the westward against the prevailing wind and currents.

The east wind which sets in at the commencement of a revolving gale, may veer either by the north or by the south, according as a ship may be situated in the right or the left hand side of a progressive whirlwind; but the westerly wind of high latitudes will neutralize the effect of this east wind, when it does not blow hard, so that it may sometimes produce a calm.

For example, if the wind's force in a whirlwind be represented by the number 4, and the force of the general atmospheric current of air blowing at the same time, be also represented by the number 4, the east wind in the whirlwind will be balanced by the general west wind prevailing beyond the limits of the whirlwind; but on the opposite side of the whirlwind, the wind's force will be doubled, so that it may be equal in strength to a gale. This is supposed to be the explanation of westerly gales in high latitudes blowing harder than easterly ones.

A ship's best course from England to Bermuda therefore, may neither be by the straight course, nor yet one by the trade winds, but it may sometimes be in a curved direction to the northward.

The principle of taking advantage of the changes of revolving winds, by sailing free on curved lines, is applicable to high latitudes, in both hemispheres, when ships are sailing westerly. W. R.

Government House, Bermuda,
11th May, 1842.

Proceedings of the Asiatic Society.

Wednesday Evening, the 6th December, 1843.

The usual Monthly Meeting was held at the Society's Rooms, on Wednesday Evening the 6th instant.

H. Torrens, Esq. Vice President in the chair.

The following new Members proposed at the last Meeting, were balloted for and declared duly elected:—

Lieutenant Hickey, 1st N. I. and Willis Earle, Esq.

Associate Member.

The Rev. W. J. Long.

Corresponding Members.

Mons. C. Alex. Challaye, late French Consul in China.

Mons. M. H. E. de Chonski, Secretary of the Consulate in China.

And the following new Member:—

R. Macdonald Stephenson, Esq. was proposed by Col. Forbes, and seconded by H. Torrens, Esq.

The Secretary reported to the Meeting, that the reprint of Lieut. (now Major) Leech's Grammar and Vocabulary of the Beloochee and Punjabee languages, which had been requested by the Right Hon'ble the Governor General, was completed, and the Government copies sent into the Foreign Secretary's Office. .Spare copies had also been struck off for the Society, and were now on the table.

Also, that the Library contained only the Philosophical Transactions up to the year 1837, although it appeared from a printed list in the work that the Asiatic Society of Bengal, was one of the public bodies with which the Royal Society exchanged Transactions. He therefore requested to be authorized to write to the Royal Society on the subject; which was agreed to.

The Vice President introduced to the Meeting, Messrs. C. Alex. Challaye, late French Consul in China, and H. E. de Chonski, Secretary to the French Consulate at Canton, as Members of the Societé Asiatique de Paris, and themselves Orientalists of much merit. These gentlemen were now on their way to Europe, and he proposed from the chair, that they should be elected Corresponding Members of the Society; which was unanimously carried.

Mons. Challaye presented to the Society a copy of the work of the Rev. Pere Callery, Missionaire Apostolique in China, entitled "Systema Phoneticum Scripturæ Sinicæ," as also two specimen numbers, in French and English, of his proposed translation of the great Chinese Encyclopedic Dictionary of Kang-hi, known hitherto to Europeans only through the translation of its abridgement, entitled *Kang-hi-tze-tien*, by Dr. Morrison. For the proposed translation of the entire Encyclopedia by M. Callery, the patronage of the Society was requested.

The Vice President after detailing at some length the indefatigable labours of the Rev. M. Callery, in the publication of his first work, the Systema Phoneticum, which was mostly performed, down to the meanest details, by his own hands, rendering it thus also a monument of the untiring energy of a man of genius, referred to the specimens of the new work on the table as one in the highest degree worthy of the

patronage of the Society. He much regretted the absence of the Honorable the President, as he thought he would doubtless have earnestly supported the proposal he intended to make, which was, that the Society should subscribe for two copies of the Encyclopedia, and address Government, requesting also that its support be accorded to M. Callery's most useful and honourable enterprise.

The Sub-Secretary thought that the absence of the Honorable the President was scarcely to be regretted, as any proposal to Government now carried, would thus come more independently from the Society, as a body, in his absence. He observed, that it was scarcely possible sufficiently to appreciate such an undertaking, since at the present moment no Englishman could be indifferent to any work, great or small, which could throw any light whatsoever on any matter relative to China or the Chinese.

Some conversation ensued, when it was elicited, that (as stated in the preface,) the work will extend to 20 Volumes of 600 pages each, royal octavo, and the price will be 25 francs per Volume. It was proposed by the Vice President, seconded by Mr. Heatly, and carried unanimously, that the Society should subscribe for two copies, and that it should be referred to the Committee of Papers to frame a letter for the approbation of the Society at the next Meeting, in which the support of Government might be solicited for this important work.

The Vice President brought to the notice of the Meeting, that it had been long considered by many Members of the Society, that the Busts were placed in far too elevated a position, and that it would be proper to lower the pillar-pedestals on which they stand, so as to bring them to the usual height at which Busts were placed. He also submitted to the Meeting, a specimen Slab on which it was proposed to inscribe the names of the persons whose effigies were represented, placing it against the pillar beneath the Bust; but he stated, that as some difference of opinion might arise as to the proper mode of inscribing the name, he begged to submit the question for the decision of the Society.

After some conversation, it was agreed upon, that a Committee to be composed of

N. B. E. Baillie, Esq.
F. G. S. Heatly, Esq., and
H. Piddington, Esq.

be requested to settle this matter.

The Secretary also stated, that as a reprint of the Lithographed Rules of the Society which were distributed to new Members was necessary, he was desirous of know-

ing if it was the pleasure of the Society that any alteration should be made in them.

Referred to the Committee of Papers for report.

The following list of Books presented was read:—

Books received for the Meeting of the Asiatic Society, on the 6th December, 1843.

The Calcutta Christian Observer, November and December 1843, New series, vol. iv. Nos. 47 and 48.—Presented by the Editor.

The Oriental Christian Spectator, new series, Bombay, November 1843, vol. iv. No. 11.—Presented by the Editor.

The Calcutta Journal of Natural History, April 1843, vol. iv. No. 13.—Presented by the Editor.

Journal of the Agricultural and Horticultural Society of India, 1843, vol. ii. No. 9. Presented by the Society.

Proceedings of the Academy of Natural Sciences of Philadelphia, vol. i. Nos. 20, 21, 22 and 23, November and December 1842, and January and February 1843.—From the Society.

Report of the Twelfth Meeting of the British Association for the advancement of Science, for 1842. London, 1843.—From the Association.

Papers regarding the Scinde and Begaree Canals, in the Neighbourhood of Shikarpore, in Upper Scinde. Calcutta, 1843.—From Government.

The Zoology of the Voyage of H. M. S. Sulphur, Mammalia, by J. E. Grey. London, 1843.—Purchased.

Proceedings of the Zoological Society of London, 1842, part x.—Presented by the Society, through Dr. McClelland.

List of the Fellows and Honorary Members &c. of ditto ditto. London, 1842.—Presented by the Society, through Dr. McClelland.

Memorandum upon the state of Indian Bazaar Weights and Measures. Calcutta, 1843.—Presented by Mr. Landers.

The following Letter from the Librarian, with its accompanying documents, was read:—

To H. Torrens, Esq. *Secretary, Asiatic Society.*

Sir,—Having examined the rules of the Society's Library, printed in the 16th volume of the Asiatic Researches, I have the honour to state, that with a few exceptions, they fully answer their intended purpose of preserving the books without inconvenience to the Members of the Society; but as it appears from the Library records, that those rules which provide for the safety of the books have never been adhered to, I beg to suggest the propriety of now enforcing them, and to propose the following alterations and additions:—

I. Books are to be borrowed by written or personal application to the Secretary: in either case, the person applying is to furnish a written receipt, specifying the name of the work, and the time for which it is borrowed; at the expiration of which, he is to return the Book borrowed, or renew his application for an extended loan of it.

This form of the rule is, I think, preferable to the former, it being more regular to fix a certain period for the keeping of the books, and also as it does not exclude other Members from the use of a particular work.

II. To add the following rules:—

1. The Librarian should be authorised to call in any work which is detained beyond the time fixed by the preceding rule.

2. All works, borrowed from the Library, should be returned once a year, viz. the first of October, in order to enable the Librarian to have the most efficient control over them, and to report to the Secretary on the state of the Library.

3. Valuable manuscripts should not be removed from the Library, and no work of the Oriental division of the Library should be borrowed by Native gentlemen, not Members of the Society, without a special order of the Secretary.

In conclusion, I would propose, that the rules of the Library be printed and annexed to the Catalogue.

I have the honour to be, Sir,

Asiatic Society, 14th October, 1843. Your most obedient servant,

G. Roer.

Memorandum by the Sub-Secretary.

With reference to new arrangements respecting the Library, I beg on the part of the Curators to suggest, that some rule like the following be laid down for the guidance of the Librarian, and for assuring to the Curators that control over the books which are specially required for their several departments, without which they must be seriously impeded, and may often be totally stopped in the progress of their labours.

"*Rule.*—All books being books of general or special reference in the various branches of Natural History, in the departments of the Zoological, Geological, and Mineralogical Curators, to be understood by the Librarian to be books of reference for the use of those officers, and as such, not to be lent out of the Library.

"The Curators are farther to be allowed to take over for daily use, such books as they may select for that purpose, giving the usual receipt to the Librarian."

The motive for this rule is, farther, not only to assure to the Curators the use of books often bought specially for their use, but moreover because there is no question, not only that books of daily reference to the working Naturalist are in a manner almost appropriated and kept for months, and even years, by parties who often make but little use of them, but that such works often disappear entirely from the Library;—this has certainly occurred with books relating to my own department, and which I cannot now obtain in Calcutta.

H. Piddington,

Sub-Secretary and Curator Museum Econ. Geol. and Mineral. Geol. Dept. &c.

Memorandum by the Secretary.

I have the honor to submit a new Rule for the Library, having special reference to the class of works ordinarily required by the Curators to the Society in the course of their labours.

Hand books and text books of science should evidently be kept in the reach of parties actively engaged in Scientific investigation. For this purpose they either be detained in the Library as proposed, or, as opportunity occurs, procured in duplicate, one copy being always reserved as *the Museum copy.*

H. Torrens,

Vice President and Secretary, Asiatic Society.

I should just venture to suggest, that for the volumes specially entrusted to the Curators, in cases where no duplicates exist, the Curator may be permitted to lend them out to Members on a receipt to himself, as it will then be in his power to call them in as soon as he likes. S. G. T. Heatly.

Resolved—That the proposed amendments be adopted as the future Rules for the Library.

Read the following Letters from Government, accompanying the Books and Papers to which they refer:—

No. 2556.

From Under-Secretary to the Government of Bengal, to H. Torrens, Esq. *Secretary to the Asiatic Society, dated Fort William, 13th October,* 1843.

Sir,—I am directed by the Deputy Governor of Bengal, to forward Copy of a Letter from the Superintendent of Marine, No. 591, dated the 23d ultimo, and its original enclosures, relative to the corrosive effects of Salt-water on Iron, with His Honor's permission for the publication of the whole, or any part of the information therein contained, on this highly important subject. I have the honor to be, Sir,

Your most obedient servant,

Cecil Beadon,

Under-Secretary to the Government of Bengal.

No. 241, of 1843.

From W. Edwards, Esq. *Under-Secretary to the Government of India, to the Secretary to the Asiatic Society, dated Fort William, the 3d November,* 1843.

Foreign Department.

Sir,—I have the honor to transmit for the use of the Society's Library, the accompanying Copy of Papers regarding the Scinde and Begaree Canals in Upper Scinde, printed by order of the Right Hon'ble the Governor General in Council.

I have the honor to be, Sir,

Your most obedient servant,

W. Edwards,

Under-Secretary to the Government of India.

No. 1034.

From Under-Secretary to the Government of Bengal, to H. Torrens, Esq. *Secretary to the Asiatic Society, dated Fort William, 13th November,* 1843.

Revenue.

Sir,—By direction of the Deputy Governor, I have the honor to forward for such use as the Society may wish to make of them, the accompanying Papers relative to the variation of the Compass throughout the Bengal Presidency.

2. You are requested to return the Documents in question, when no longer required.

I have the honor to be, Sir,

Your most obedient servant,

Cecil Beadon,

Under-Secretary to the Government of Bengal.

Read the following Letter from E. C. Ravenshaw, Esq. accompanying a sketch of the Image to which it refers:—

To the Secretary of the Asiatic Society, Calcutta.

Sir,—I have the pleasure to send a copy of an Inscription on the back of a small brass Image, about six inches high, which was recently found at Bodh Gya, by the Mohunt of the Monastery of the Sunyasis, while making excavations among the ruins of the Old Fort. The writing is illegible by the scholars of these parts, but it is probable that some of the eminent Pundits employed by the Asiatic Society may be able to decypher it. If they should be successful in so doing, I shall feel much obliged by your favoring me with a translation, as it would be very interesting to ascertain the precise date or æra in which these images of Bodh or Mohamuni were made and worshipped.

Your obedient servant,

Gya, November 19, 1843. E. C. Ravenshaw,

P. S.—The Tiara on the head of the Image is very peculiar; a Sketch is enclosed.

The following was the rendering, in Sanscrit characters, of the Inscription by the Society's Sanscrit Librarian :—

श्रीब्रह्मवरदहेतुश्शामलदम्भाय ॥

Rasmohun Nayavagish,

Sanscrit Librarian, Asiatic Society.

And the following in English and Sanscrit is given by Baboo Saroda Presad :—

श्रीब्रह्मवरदहेतु सामन्त दे [व ?] स्यायं ॥

Brahma Varoda hetú Sámanta Devasyáyam.

Literal Translation.

This (this image) is of Sámanta Deva, who yields blessings for Brahma, (for obtaining true divine knowledge,) and who is the cause (or source) of Brahma (or extinction in Brahma,) *i. e.* salvation.

Note.—Here the word Brahma has two meanings ; viz. True divine knowledge and extinction in Brahma, or the supreme creator, *i. e.* salvation.

Besides next the letter दे dé, one व B-a is indispensably necessary to be inserted, as without it no sense can come out.

The character appears to be the character of the 9th Century.—S. P.

Read a Note from Major Ouseley, Agent to the Governor General, North-West Frontier, forwarding a skin of the black Leopard, which he states, is considered a novelty in that neighbourhood, *i. e.* Chota Nagpore.

Read Letter from Captain Russell, Commanding the Honourable Company's Steamer *Ganges*, reporting his trip to examine the site of the late Volcanic Island in the Cheduba Archipelago. This letter will be found in the Report of the Curator Museum of Economic Geology, as following there, naturally, the letter of instructions given to Capt. Russell on the part of the Society.

REPORT OF THE CURATOR MUSEUM OF ECONOMIC GEOLOGY.

Report of the Curator Museum Economic Geology and Mineralogical and Geological Departments, for the month of November.

Geological and Mineralogical.—As we have heen unable to despacth a scientific geologist to visit the Cheduha groupe as at first recommended, all that could he done was to frame a letter for the Captain of the Steamer, so as to enahle him to do the best he could in the way of collecting what he might meet with, and this he has done very zealously. I have hut just received his collection, and shall therefore be obliged to delay my report upon it till I learn the localities visited, and other particulars, but the following copy of our letter should he placed upon record :—

Captain Russell, *Commanding H. C. Steamer Ganges.*

Sir,—As it is not improhable that much preliminary geological, and even some mineralogical knowledge may he ohtainahle hy yourself and Officers on your approaching survey trip to the Straits of Cheduha and adjacent Islands, I have been desired hy the Honorahle the President of the Asiatic Society, to point out to you briefly, how this may be hest accomplished.

Geological.—Your first object is, I helieve, to ascertain what traces, as shoals, &c. may remain of the Volcanic Island, which recently rose and disappeared off the S. E. point of False Island, near Cheduha. If the place of the new island can he correctly ascertained, and the water be not too deep, specimens of the scoriæ and mud should be, if possihle, ohtained hy dredging and diving, with as many shells, stones, &c. as can be had, particularly if with marks of action of fire. A 6-dozen wine chest full of these or more will he none too many, *if there are many kinds*, and the more variety the better.

Whether the Volcanic shoal has any connection with the reef to the South of False Island or not, specimens taken up to the dry reef and the shores of the island, should also he collected; the island itself should be carefully examined and a section of it taken, if possihle, numhering or marking all the varieties of rocks, soils and corals, &c. &c. to correspond as A, B, C, &c. The names you give to the stones or rocks, *do not signify in the least.* You may call them any name you like, hut the points are *their exact place*, and how the beds of them lie, if the lines of beds can he seen, as thus :—

"L. No. 1 to 7.—Hard blue stone; beds slope with their faces to the S. E. and are elevated ahout 30° from the sea horizon, the line of the faces of the beds lies N. and S.*

M.—Confused masses of yellow, dark hrown, and hlack stone and boulders with shells, no heds to be made out.

N.—Level beds of soft sandstone much worn hy the sea," and so forth: noting *immediately* every specimen or lot of specimens as obtained.

The other small Islands should also he visited and examined in like manner.

Traces of elevations are, according to Captain Halstead, every where to he seen on Flat Island, in beaches of shells at different heights, particularly at "Square Rock," (see his chart.) A good description with plenty of specimens from this rock and the Island would be very desirahle. These should be described, measured, and plenty of specimens hrought from them, as well as from the present beach; not only to enahle us to judge of the numher of risings, hut also if there have heen *sinkings again* betwcen the dif-

* This is called the *dip* and the *strike* of rocks, or mineral beds, or strata.

ferent risings. For these we require plenty of specimens, (two or three boxes full,) both of the rock of the beaches and of the beds of shells, oysters, &c. as found fastened upon and in them, and lying loose upon the ledges, with the various heights marked as nearly as can be measured or guessed. The inland beds, rocks, peaks, &c. are usually the most interesting, as being the most ancient. Any imbedded shells, skeletons of fish, &c. are of the greatest importance.

Mineralogical.—Any veins in the rocks, remarkable stones, ores, &c. should be collected; five to ten specimens at least of each kind.

It appears that a rich Copper ore has been found upon Round Island by a native searching for Coal, employed by Captain Williams, who has been requested to have him ready to accompany you, if possible, to point out the spot. Specimens of the rocks or soil in which, and *with* which, the Copper ore is found should be obtained, as also a good supply of the ore itself, if obtainable. Shining and glittering ores you will readily pick up if met with, but as these are not usually the most valuable, a few of the plain *stone-like* looking ones are sent herewith. All blue, green, red, or yellow stained rocks, cliffs, banks, or veins should be carefully examined; of these the red and yellow are most frequently Iron, and the blue and green often Copper. Spots which appear thus coloured, and nearly or quite bare amongst the surrounding vegetation, should be searched and dug into, and specimens of all the stones, earth, &c. taken. All beds of streams, fissures of rocks and strata, and often the sand and gravel of rivers afford you chances of picking up something of value in this way.

Amongst the specimens you will receive a very small one of a very important, though very worthless-looking one, which is the Asphalte of France, from which the asphaltum terraces and roads are made. This you will easily recognise by its burning, and by its effervescence with acids. Any earthy-looking stones resembling it should be collected; as also specimens of Mineral Tar, if any thing of the kind is found. This is not the petroleum or earth-oil, but a thick, tarry, and almost pitchy substance which has not the smell of the earth-oil, but rather that of leather, but very faint. Where the one of these two mineral products, the Asphalte and the Mineral Tar, is found, the other is most probably present, and should be carefully looked for.

You will receive with the present a printed Pamphlet, containing directions in detail for the collecting of Geological specimens by persons unacquainted with science, in which I have marked a few passages in pencil; these with the foregoing, will, I trust, enable you to add something to our knowledge.

The Asiatic Society of Bengal, will owe you their heartiest acknowledgments, should your search be so conducted as to lead to the collection of a complete set of Geological and Mineralogical specimens from the site to be examined, and I am directed to express the hope of the Society, that you will be facilitated in conducting your search deliberately, by instructions from the Marine Department admitting of some license of interpretation as to the length of time available to you for it.

I have the honor to be, Sir,
Your faithful servant,
H. Torrens,
V. P. and Sec. As. Soc. of Bengal.

Capt. Russell's Letter to Mr. Torrens is as follows. His chart and report to Government have not yet reached us.

To H. Torrens, Esq. *Secretary to the Asiatic Society.*

Sir,—I have the honor to state, that the Hon'ble Company's Steamer *Ganges*, after having taken on board the Soogrees of Cheduba and Flat Island, arrived off False Island on the 20th of November, when I took with me the natives of both Islands, who pointed out to me where the Volcanic Island was. I have examined and surveyed the spot, and find it was situated on a continuation of the Reef extending to the Southward from False Island, which is only a sand bank surrounded with rocks, with a few small shrubs on it. Where the Island was, there is now from two and a half to three fathoms water, with the bottom so rocky, that I could not succeed in getting any of it up.

The following is an account of the appearance of the Volcanic Island, by the natives of Cheduba and Flat Island, which occurred on the 26th, 27th, 28th, and 29th of July, 1843:—

"About our morning meal, or seven or eight o'clock, on the morning of the first day, we heard a great noise, and saw fire rising out of the sea, which continued for four days; on the second day we saw a small Island newly formed in the sea, between "Flat Rock" and "Round Rock," (names will be seen in the chart,) about the size of the sand bank called False Island.

"We saw the newly-formed Island for a month, but could not approach it on account of the boisterous sea on the coast. We felt an earthquake before we saw the fire in the sea; in the month of October we came out in our boats, to look for the Island, but saw nothing. The rocks, as they now lay, are of the same number and position as before the appearance of the new Island.

"We did not feel the earthquake felt at Ramree on the 30th of October last, it was felt on Cheduba Island by some of the natives."

I am sorry I could not procure you specimens of the bottom where the Island was, as it was hard rock. I was unable to do so, on account of the depth of water,

I have the pleasure of forwarding you a specimen of Copper Ore from Round Island, found by Captain Williams while I was at False Island, and another of Iron I believe, picked up on Round Island by one of the natives; these were the only ones procured on that Island.

I also send specimens of the Rocks, &c. of Flat Island, and the mud thrown out from the Volcano at the same place.

Also a specimen of Iron Ore from False Island, and the different rocks and mud, formed stone there, which appears to me to have been the same sort of mud petrified, as I send specimens of, thrown up from the Volcano on Flat Island.

There are also specimens of Treble Rock to the Southward of where the Volcanic Island was, as you will observe in my chart, forwarded to the Superintendent of Marine.

I also send a specimen of Iron Ore thrown up from a Volcano, about five miles to the Southward of Kyouk Phyoo, on Ramree Island. I regret that I had not further opportunities of gathering specimens, which the shortness of my stay prevented, on account of the Island having disappeared. I have the honor to be, Sir,

Calcutta, 1st December, 1843. Your obedient servant,

J. Russell,

Commander of the H. C. Steamer Ganges.

Capt. Boyes of the 6th Cavalry, who it will be recollected was proceeding on a trip to the Himalayan Passes, and was unfortunately compelled to return by the loss of all his baggage down a precipice, has given us new cause to regret this most untoward accident, for he has sent us a most beautiful series of geological specimens as far as he went; viz. a little beyond Melum, and I doubt not that when his Memorandum reaches us, this little collection will be truly an ornament to our Museum. Capt. Boyes has proceeded from the hills to Bundlecund, and I trust, that in that interesting route, he will be able to enrich us farther. It is most certain that zeal and ability abound with him, if he can only find time.

Mr. Mornay has obliged us with an analysis of some of the singular Copper Ore sent up from Round Island in Capt. Williams' second despatch, which though it may be now read, should, I submit, in justice to that gentleman, have a separate place in the Journal, for it is certainly a very curious one, and a natural amalgam little to be looked for. The presence of the Mercury in the Ore would allow us to hope, that when better acquainted with this most interesting spot, that valuable mineral may be found thereabouts. Mr. Mornay finds it to be an alloy of Copper, Titanium, Mercury, Lead, Cobalt, and Iron, in different proportions, the different pieces varying in their composition.

Messrs. Weaver and Co. have been good enough to send us two fine specimens of petrified palms from Upper India, the exact locality they have not yet been able to ascertain for us.

We have received the following letter from Dr. Tamnaw, of Berlin, reiterating the offers of exchange of Minerals made by him in 1841.

*To Messrs. the Directors of the Bengal Asiatic Society, Calcutta.**

Berlin, Prussia, July 20, 1843.

Gentlemen,—A long while before I had the honour to receive your kind and esteemed letter, dated February 3, 1841, and I saw with great pleasure, that you do not refuse my proposal for an exchauge in Minerals and Fossils from Europe, and particularly from Germany, for such mineralogical productions from the East Indies. However, Gentlemen, you did not wish, that I may forward to you a first invoice, as like as I did offer, because this part of your collections at the time were not so ordered for deciding what you may wish to receive, or what you may be in a state to give. You promised at the same time to make an invoice to me in fine and well cristallized Minerals from Hindostan, for which I should return such of Europe.

I take the confidence, Gentlemen, to refer myself to your remembrance, and so repeat the offer, which I made in my first letter. I should be exceedingly anxious to enter with you in such a relation of exchange; the science of Mineralogy may never be studied without collections so large as possible, and particularly in a country so large and so very unknown than yours it must be advantageous for the science, if the common sense for it may be awaked by an augmentation of the public collections by the productions of foreign countries. I repeat my offer to make to you a first invoice in the manner and in the way, as I said it in my first letter, and I request you to

* This letter is printed *verbatim*, being a record of proceedings.

inform me so soon as possible, if your arrangement of collections may be so much proceeded, that it should be desirable to you to receive any things from Europe in the way of exchange.

At the same time I take the confidence to include here some letters and little addresses, expressing my wishes of exchanging Minerals. In the interests of the science I beg you, Gentlemen, not only to communicate those letters and addresses to such of your honourable members or other scientific Gentlemen, friends to Mineralogy, who you may think able and willing to enter in such a relation of exchange with me,—but also to give their consent such a publication as possible in the scientific world of your country. I should be exceedingly indebted to you for every one communication, which could bring me to the desired relation of exchange, and I believe it advantageous to both parties, and to the science in general.

I expect your honourable reply, and I have the honour to remain with the greatest consideration and respect,

Gentlemen,

Your most obedient servant,

Dr. Fr. Tamman, *Jun.*

Address to Fr. Tamman, jun., Berlin, Prussia, care Mr. H. Pontoppidan, Hamburgh.

CIRCULAR.

Berlin, Prussia, July 17, 1843.

Sir,—In possession of one of the greatest and most beautiful collections of Minerals we have on the Continent, I take the confidence to propose to you an exchange of fine and well cristallized Minerals and Petrifactions from Germany, Sweden, Norway, &c. &c. for such Mineral productions of your country. The conditions which I propose, are the most simple in the world. I make you the first invoice, and after its arrival, you return me in British Minerals, what you may think an equitable and just equivalent. The expences for the transport must pay, who receives the box.

Being a scholar of celebrated Mr. Mohs, I occupy myself particularly with Cristallography, and *cristallized* specimens are, following, particularly desirable and interesting to me. I collect not petrifacts, and occupy myself less with Geology than with Mineralogy; following I prefer to receive minerals and cristals, also for the sent petrifacts, supposed that you may not have in the last rare and here unknown things. In relation of exchange with a great number of friends of the science I consent to receive a number of specimens of the same sort, which perhaps you may have abundantly, supposed that the sort may be interesting, and the specimens fine.

On the other side, I give you of the things which I can offer in this moment a Catalogue, and also a list of those specimens of your country, which I desire particularly. Remark, that those, which are underlined, are the most desirable. Have you, Sir, some scientific friends, who you may think able and willing to enter in such an exchange with me, then, Sir, I should be highly indebted to you for the communication of their addresses to me, and of the mine, which you find on the end of those lines, to them.

I expect, Sir, your honourable reply, and I have the honour to remain, Sir,

Your most obedient servant,

Dr. Fr. Tamnan, *Jun.*

Catalogue of those Minerals, which I can offer in this moment.

A. From Sweden.—Blue Spinell xx, Chondrodite, Petalite, Spodumene, Lepidolite. Indicolite, Pyrrholite (new), Amphodelite (new), Glance Kobalt xx, Dichroite, Cerite, Cerine, Gadolinite, Yttro-Tantalite, Orthite, Pyrorthite, White massive Topaz, Pyrophysalite xx, Massive Emerald, Albite, Yttro Cerite, Fluo-Yttro-Cerite, Laumonite, Fahlunite, Automolite xx, Yellow Triklasite, Epidote, Asbestus, Red Silicate of Manganese, White Scapolite, Sphene xx, Tourmaline xx.

B. From Norway.—Zircon xx, Polymignite xx, Pyrochlor xx, Labrador spar, Elaolite (green and red) ,Apatite, Tourmaline xx, Ilmenite xx, Noble Serpentine, Anthophyllite, Massive Apatite, Rutil xx, Foliated Titanic Iron Ore, Talcite, Pyrope, Titanic Iron Ore, Telluric Bismuth glance, Rose Qnartz, Garnet xx, Skapolith xx, Epidote xx, Oligoklase xx, Felspar xx, Stilbite xx, Kolophonite, Blue Apatite, Fluor Spar xx.

C. From Bohemia.—Sphene xx in Klinkstone, Augite xx, Amphibole xx in Iron Clay Arragonite xx, Analcime xx, Chabasite xx, Natrolite xx, Apophyllite xx, Ryakolithe xx, Hyalite, Pyrope, Miemite xx, Bitter spar xx, Opal jasper, Porcelain jasper, Tungstate of Lime, Molybdena, Pitch Opal, Peastone, Wavellite, Egeran xx, Apatite xx, Fluor Spar xx, Quartz xx, Heavy Spar xx, Carbonate of Iron xx, Felspar xx, Comptonite xx.

C. a. From the Harz. Thuringia and Saxony.—Celestine fibrous xxx. Felspar in Pseudomorphous xx, Braunite xx, Hausmannite xx, Manganite xx, Pyrolusite xx, Harmotome xx, Apophyllite xx, Stilbite xx, Calcareous Spar xx, Fluor Spar xx, Tourmaline xx, Bournonite xx, Grey Antimonial Ore xx, Carbonate of Iron xx, Uranite xx, Andalusite xx, &c. &c.

D. From Bavaria.—Anatase xx, Chiasotolith xx, Felspar xx, Tourmaline xx, Arseniate of Iron xx, Carbonate of Iron xx, Sulphuret of Nickel, Tronsit, (Breithaupt new), Garnet xx, Zoisie, Rose Quartz, Triphylin, Triplite, Vivianite xx, Dichroit, Beril xx, Sphene xx, Grey Antimony, Magnetic Iron Pyrites.

E. From other countries.—Yellow amber from the Baltic, Olivine xx, Manganese Ores, etc. from Saxony. A number of things from Tyrol, the Hartz, Salzburg, and other parts of Germany. A few specimens from Iceland, the Faroe Islands, Finland, Hungary, Italy, &c. A great quantity of interesting things from North America, etc. etc.

F. A number of fine and interesting Petrefacts from Germany, particularly from Bohemia, Bavaria, etc. etc. Sweeden, Norway, etc. etc.

List of such British Minerals, which I wish particularly to receive.

1. *From England and Wales.*—Hatchettine, Bournonite xx, Haytorite xx, Brookite xx, Oxyde of Tin xx, Vivianite xx, Cube Ore xx, *Axinite* xx, Pinite xx, Sulphuret of Copper xx, *Arseniate of Copper* xx, Phosphate of Copper xx, Tourmaline xx, Sulphate of Lead xx, Cupreous Sulphate of Lead xx, Arseniate of Lead xx, Arsenio Phosphate of Lead xx, Chlorate of Lead xx (from Mendip), Arsenio Sulphate of Lead xx, Ruby Copper xx, Apatite xx, Topaz xx from Cornwall, Fluor Spar xx in its diverse forms, Heavy Spar xx, particularly the great crystals from Alstone Moor and Durham, Carbonate of Barytes xx, Bi-Calcareo Carbonate of Barytes xx, Baryto Chalcite xx, Sulphate Carbonate of Barytes xx, Tungstate of Lime xx, Tungstate of Iron xx, Hydrous Oxide of Iron xx, Carbonate of Iron xx, Anatase xx, Uranite xx, Felspar xx, Murchi-

sonite xx, Blende xx, Sulphuret of Tin xx, Tennantite xx, Sulphuret of Copper xx, Copper Pyrites xx, Fluellin xx, Childrenite xx, Wavellite.

2. *From Scotland.*—*Greenockite* xx, Prehnite xx, Felspar xx, Chabasite xx, Stilbite xx, Withamite xx, Harmotome xx, Brewsterite xx, Edingtonite xx, Laumonite xx, Strontianite xx, Mesotype xx, Sulphato Carbonate of Lead xx, Sulphato Tri-Carbonate of Lead xx, Carbonate of Lead xx, Cupreous Sulphate of Lead xx, Cupreous Sulphato Carbonate of Lead xx, Topaz xx from Mar and Cairngorm, Hydrate of Magnesia from Swinness, Thomsonite xx, Stellite, Apophyllite xx from Fifeshire, Red Hewlandite.

3. *From Ireland.*—Felspar xx from Newry, Topaz xx, Beril xx, Antrimolite, Levyine, Gmelinite, Chabasite xx, Apophyllite xx, Natrolite, Harringtonite, Analcime xx, Erinite xx.

4.—Minerals from the East Indies, New Holland, the Cape of Good Hope, Brasil, Peru, Chili, Mexico, Spain, and Portugal.

5. *From Hindostan.*—Apophyllite and Poohnahlite xx from Poonah, Mesotype xx, Stilbite xx, Zircon xx, Diamond xx, Corundum xx, (Sapphir xx), Ceylonite xx, (Spinell xx), Red Tourmaline xx, etc. etc.

Address: Dr. Fr. Tamnan, Jun. Berlin, Prussia, care of Mr. Ed. Nicol, Stettin, or Mr. H. Pontoppidan, Hamburgh, or Messrs. F. Behm and Co. Dantzig.

In reply to it I may say that we shall soon, I trust, be in a position to say what we can spare, but that we have first heavy debts to pay off, for which the very few duplicates of rare and Indian minerals we possess will certainly not be too many. And with reference to this matter I may repeat here what I had occasion to remark, touching both geological and mineralogical specimens in India, in a former report namely; that we unfortunately receive, for the most part, but single geological series, or specimens of minerals, and then that twenty years may elapse before we obtain another; so that while in Europe no sooner is a mineral or geological locality known as producing something of value to collectors, than it is ransacked, and in fact made a mine of, till the supply equals the demand, or as is sometimes the case, till the mineral is exhausted; in India we obtain a notice and specimens, or a series or two, and then even at our very doors, no more are to be obtained till another geologist or mineralogist visits the spot. I quoted there the case of Captain Franklin's specimens from the Diamond mines of Punnah; I may add in explanation of the words "our very doors" used above, and as a striking instance of what I wish here to explain, that I have now been for the last two years endeavouring to obtain a supply of the vegetable impressions from the coal shales of our Burdwan coal mines, and that I have not yet succeeded! We have a very beautiful collection of them presented by Dr. Royle ten or fifteen years ago, but none to spare; and yet these things are but the rubbish of the mines!—and within fifty miles of Calcutta!

Museum of Economic Geology.—I have here the pleasure to announce the discovery of an Indian Lithographic Stone, *almost* equal to the German. It is another of the specimens sent down by Capt. Shortrede from near Rewah, as noticed at the last meeting and Mr. Black's letter relative to it is as follows:—

To H. Piddington, Esq. *Sub-Secretary to the Asiatic Society, Calcutta.*

Sir,—I have pleasure in sending a few impressions taken off the two little stones you first sent me; those from the larger piece have come off well, and I think if a slab of

the size of 8 or 10 inches, or a little larger, could be obtained, I could give a favourable report of it. From what I have been able to ascertain, I think this quality will answer remarkably well, and as far as my experience enables me to judge, being 20 years practically engaged in Lithographic Printing, I can safely say I have not met with any Indian stone approach so near to the German, which is the best we now have.

Of the smaller piece I cannot form an opinion, being too small to admit of a fair trial, but it takes a good polish, and may answer pretty well for Lithographing written forms upon, if not too soft; the black marks upon it would be an objection to its being used for taking off drawings.

I have not been able to try the other specimens yet, but will report upon them as soon as I am able to do so.

As requested, I have pleasure in sending the accompanying three pieces of Europe Stones, of such as I use in my establishment, and remain,

Sir, your obedient faithful servant,

Asiatic Lithographic Press, 3, *Hare Street*, THOS. BLACK.

13*th November* 1843.

This is certainly most satisfactory, and I have written to Capt. Shortrede to obtain a larger piece as desired, as also to know if his public duties will admit of his shortly visiting the spot with sufficient leisure to examine the quarry or quarries from whence the heap of stones, amongst which this fine specimen was found, was taken; or if it may be necessary either for him or for the Society to address Government on the subject, which I venture respectfully to submit it might with great propriety do. The probable direct saving to Government in its own lithographic establishments at the three presidencies, though a large item, is a mere trifle when compared with the immense benefit to the native literary community, to whom the high price of lithographic stones is almost a prohibition upon many enterprises of great utility; the price of good German stones varying in Calcutta, from six annas to twelve annas a pound weight. A stone large enough for an octavo page, costing thus from 25 to 40 Rupees: Large ones for maps from 80 to 120 Rs. or more. If the quarry should afford a good supply, and water carriage down the Tonse be available, it is quite possible these stones may become an article of export at least to various parts of India, if not to Europe.

Mr. Black has farther obliged us with a set of specimens of the various kinds of stones used in his establishment, for the Museum. Capt. Lyrand Jacobs of the Bombay Army, has sent us a valuable printed memoir on the Iron of Kattywar, and modes of smelting the ores, and obligingly offers to procure for us a set of specimens, which will be most acceptable; and I take this opportunity of mentioning, that any thing of the nature of papers, whether written or printed, old or new, relative to any inorganic product of the earth or the processes whereby it is fitted for the service of man, will find a place in our Museum, or its records.

H. PIDDINGTON.

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